

Annex F (informative)

Application activity model

The application activity model (AAM) is provided as an aid to understanding the scope and information requirements defined in this application protocol. The model is presented as a set of activity figures that contain the activity diagrams and a set of definitions of the activities and their data.

F.1 Application activity model definitions and abbreviations

The following terms are used in the application activity model. Terms marked with an asterisk are outside the scope of this application protocol.

The definitions given in this annex do not supersede the definitions given in the main body of the text.

The viewpoint of the AAM is the users of plant spatial configuration information, including owner, architect, engineer, and builder.

F.1.1 analyze final plant design (AAM A245): examine all aspects of final design for compliance to performance criteria and generate any necessary changes required to meet these criteria.

F.1.2 as-built documents*: site plans, detailed equipment descriptions, electrical instrumentation diagrams, and P&IDs that record the actual condition of a plant at a specific point in time.

NOTE These documents aid in meeting government documentation and safety requirements. Frequently, they are simply corrections or modifications to existing design documents delivered to construction.

F.1.3 authorization plan*: high level plan, justification, and forecast for design and construction of a plant. The authorization plan describes how funds, people, and resources are to be allocated for the plant project.

NOTE It is a document used internally and is sometimes called a white paper.

F.1.4 automation tools*: the collection of software and hardware tools used to assist the activities involved in the life cycle of a process plant.

F.1.5 basic laws*: those elements of natural and human laws affecting any activity in the life cycle of a process plant.

EXAMPLE These laws include operating rules and guidelines as established by U.S. federal regulatory agencies such as the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA).

F.1.6 bids*: commercial proposal by supplier for provision of equipment, supplies, or services.

F.1.7 calculate heat and mass balance* (A212): calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

F.1.8 capital appropriation*: authorization of funding for capital project or expenditure.

F.1.9 change request: a request made by an user of data to revise the original or current version of something due to errors, omissions, or other reasons, such as new requirements.

NOTE 1 A request is followed by review, analysis, and approval. Change requests are tracked in terms of cost and schedule (a kind of mini-project within project).

NOTE 2 Change requests may be made against a supplier list, process, plant, procedure, and design basis.

NOTE 3 Change request originators include construction and operations.

F.1.10 change request (design): a request made by an user of data to revise the original or current version of the design of something due to errors, omissions, or other reasons.

F.1.11 change request (plant): a request made by an user of data to revise the original or current version of the design of the plant due to errors, omissions, or other reasons.

F.1.12 change request (procedure): a request made by an user of data to revise the original or current version of a procedure due to errors, omissions, or other reasons.

F.1.13 change request (supplier list): a request made by an user of data to revise the original or current version of the supplier's list due to errors, omissions, or other reasons.

F.1.14 chemical properties*: chemical data needed by the process engineer during design.

NOTE - This data includes, but is not limited to:

- boiling point;
- critical pressure;
- critical temperature;
- density;
- enthalpy;
- entropy;
- flash point;
- heat of vapourization;
- melting point;

- molecular weight;
- specific heat;
- thermal conductivity;
- viscosity.

F.1.15 codes: widely recognized, accepted, and sometimes legally mandated rules that apply during the life-cycle of the plant. These rules govern life-cycle activities such as design, fabrication, and operation, and characteristics such as safety. Codes are consensus documents and specifications and are sometimes a subset of regulatory requirements.

EXAMPLE The ANSI 31.x series of codes.

NOTE The design basis data specified will guide the code application, i.e., how the code is applied. (ANSI 31.3 allows overpressurizing for short periods of times to accommodate specific design basis scenarios.)

F.1.16 commission plant* (AAM A46): test the functionality of the completed plant prior to operation, develop final operating and maintenance procedures, and obtain final regulatory approval to operate the plant.

F.1.17 commissioned plant*: a plant that has been proven to be operational through commissioning procedures.

F.1.18 commissioning procedures*: step-by-step explanation of start-up actions required to commission the plant.

F.1.19 company requirements: those managerial decisions that place constraints on the operations of the company, that give direction or emphasis on areas for development, or that dictate decisions outside the local decision making paths. The embodiment of policies and regulations that govern the operations of a company.

F.1.20 confirm safety and regulatory compliance (AAM A244): establish that the final design of the plant meets specified safety and regulatory criteria.

F.1.21 construct and commission plant* (AAM A4): the process of building or retrofitting a physical plant, using plans and building materials. The layout drawings and material requirements are used to establish the physical arrangement and to procure the materials required. A plan for erecting the plant is determined from material schedules, heavy equipment schedules, labor schedules, and environmental conditions (such as weather). Temporary erection material (such as scaffolding) is procured as needed. Regulatory requirements and client requirements are used to plan and erect the plant, and for the final testing and certification for operation. The result is a completed plant that meets the testing procedures defined in the project control and approval documentation.

F.1.22 construction design specification*: a contractual document that gives the criteria and standards to be used in the construction of the plant.

EXAMPLE The specification contents include detailed construction drawings, plant layout, equipment lists, isometric models, piping and instrumentation diagrams, specifications for the construction phase of the project, and pre-commissioning, acceptance and approval, and testing procedures.

F.1.23 construction documentation*: all information related to the construction of the process plant.

EXAMPLE Documentation includes as-built reports, equipment certification, nameplate information of installed equipment, operating manuals, testing procedures, field changes, and photographs of as-built units, modules, and plant.

F.1.24 construction plan*: a description of the method(s) to be used for building or fabricating a plant or plant item.

F.1.25 construction services*: constructor activities and abilities to be used to construct the plant.

F.1.26 control and approve activities* (AAM A11): prepare plans, check conformance to plans, and arrange for any corrective actions.

F.1.27 control requirements*: requirements and criteria specified in operating procedures and safety requirements imposed on the mechanisms and systems that monitor and control plant operation.

F.1.28 corporate standards: procedures, instructions, or specifications that may be used in the execution of a plant project and are standardized within an organization. Corporate standards are not project specific, but may be used (and possibly customized) by a variety of projects. Corporate standards are developed over a long period of time as standard, recommended, or best practice.

EXAMPLE Kinds of standards include safety, design, and maintenance.

F.1.29 decommission and dispose of plant* (AAM A6): the activities during which the plant is decommissioned, disassembled, and the site either prepared for a new plant or returned to a state specified by the regulatory agencies. Records of the disposal of toxic and hazardous waste together with the location of any holes and the methodology used to plug them are produced and stored in accordance with approved procedures and guidelines.

F.1.30 decommission plant* (AAM A61): plan and complete the activities required to decommission the plant.

F.1.31 define plant operating philosophy* (AAM A231): ascertain and confirm those plant operating characteristics and activities necessary to achieve the plant owner's operational goals such as methods of production, technology, plant safety, or plant availability. This activity includes selecting types and sequences of unit operations and processing steps so that the plant production objectives can be achieved and specifying alternate or abnormal operating conditions, and procedures such as startup and shutdown.

F.1.32 define procedures, standards, guidelines, specifications, and codes* (AAM A13): specify the engineering policies to be used and determine appropriate procedures, codes, standards, guidelines, and specifications that may apply.

F.1.33 delivery dates*: scheduled date for delivery of procured items to meet or support construction.

F.1.34 deploy component or service* (AAM A35): the process whereby the part or service is delivered and the acquisition agreement is fulfilled.

F.1.35 design basis: a document provided by the plant owner or developed by the architecture, engineering, and construction (AEC) contractors that establishes or defines the information and data that Plant engineering is to be based upon. It consists of guidelines and requirements, corporate standards, codes, references to regulatory agreements, form of deliverables, and plant or production capacity.

EXAMPLE The design basis includes:

- design safety philosophy;
- environmental requirements;
- plant inputs (e.g., fuel, feedstock);
- plant license and permit requirements;
- plant operating requirements;
- plant process requirements;
- plant product or output (type and capacity);
- site parameters (geographical, meteorological, soils, hydrological);
- type of plant.

It also addresses performance objectives for the plant such as:

- capacity;
- engineering quality;
- environmental;
- investment and project economics;
- safety and health;
- schedule;
- product and plant quality;
- product and raw material storage;
- project execution;

— technology.

NOTE 1 Performance objectives usually take the form of a written document owned and maintained by the project team (consisting of members from the business, engineering, construction, and plant site).

NOTE 2 The definition for design basis is from an owner's perspective.

F.1.36 design and engineer plant (AAM A2): the activities required to develop an appropriations request and generate a construction design specification for some modification to an existing process plant or the construction of a new process plant.

NOTE The appropriation request is submitted to company management for approval. Upon approval, the construction design specification is generated.

F.1.37 design strategy*: a description of major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns that may or may not require piloting. It encompasses building technology, mechanical technology, utility technology, automation technology, schedules, scope, standards and regulations, process definition, control philosophies, costs, benefits and timings, and project approach (e.g., architectural engineering, construction management, internal).

F.1.38 disassembled plant*: all equipment items remaining after the disposal of a process plant.

F.1.39 disposal documentation*: all information related to the disposal of the process plant including acceptance and approval procedures used in disposing all hazardous materials, residues, insulation, wiring, piping, vessels, rotating equipment, site cleanup and restoration reports, and photographs.

F.1.40 dispose of plant* (AAM A62): plan and complete the activities required to dispose of the plant.

F.1.41 energy*: all utilities required in the production of useful products through the operation of a process plant.

F.1.42 engineer and design equipment (AAM A223): preliminary sizing of all major pieces of required equipment is made at this time with enough detail to obtain budget quotes.

EXAMPLE This includes equipment such as refrigeration machines, purchase power substations, secondary substations, switch gear, compressors, and boilers, as well as the major process equipment specific to the plant.

F.1.43 engineer and design plant systems (AAM A222): at the conceptual level, this is a preliminary scoping of all major modifications or additions to major plant distribution systems such as steam, compressed air, electrical power, refrigeration, water, firewater, and sewers (storm, process, sanitary). Impact on distribution pipe lines and feeder systems quantity and size are also included. A consideration of system operation in terms of reliability, uptime, planned maintenance, and winter and summer operations are vital to proper planning.

F.1.44 engineering design, construction, and operation changes: changes to the design of the plant arising from errors, omissions, new requirements, or other reasons during plant design, construction, or operation.

F.1.45 environmental impact assessment*: evaluation of project's or plant's affect on the environment.

NOTE A report is usually required by an environmental regulatory agency before construction can begin.

F.1.46 equipment characteristics (functional): describe or specify the functional requirements for the equipment: what it is supposed to do. They are items of information that describe: the service provided to the process by the equipment.

EXAMPLE For a pump, such information might include a descriptive name or title, such as 1502-B Condensate Return Pump B.

F.1.47 equipment characteristics (performance): describe or specify the performance requirements for the equipment: how much it is supposed to do it. They are items of information that describe the effect that equipment has on the process or other operational information.

EXAMPLE For a pump, such information might include flow rate, total developed head, and efficiency.

F.1.48 equipment characteristics (process): a subset of equipment functional data that describe the contribution to the process desired from equipment. Such data is specified prior to the actual selection of specific equipment to fulfill the purpose.

F.1.49 equipment characteristics (required): needed functional, performance, physical, or process attributes of an item that have a name and measurable value.

F.1.50 equipment id: an identifier assigned to a piece of equipment.

F.1.51 equipment list: a list of equipment in the process plant.

EXAMPLE An equipment list is comprised of, but not limited to:

- contract numbers (e.g., purchase, install);
- drawing references (e.g., P&IDs, plant arrangements);
- electrical load and type;
- identifier (e.g., tag);
- location (e.g., building, elevation, area, column row);
- name;
- service requirements (e.g., air, water, structural base, electrical power, control circuitry);

— spare requirements.

NOTE The equipment list may not include all equipment. It does not include miscellaneous equipment and devices (e.g., y-pattern strainers, inline flow meters, instruments) or valves.

F.1.52 erect plant* (AAM A43): utilizing plans, materials, services and labor, build a physical plant that conforms to the detailed design.

NOTE This process begins with the site preparation; grading and primary foundations poured, and temporary roads and rails created. Utility services are provided and temporary warehouses are built.

Major equipment is moved, often in pieces, and installed on foundations with supporting steel. Site permanent buildings are built, as are pipe racks and other permanent steel. Pipe runs and pipe spools are put in place with valves and miscellaneous equipment and welded or joined. Other items such as ducting, electrical, instrumentation are installed.

F.1.53 establish initial process control logic* (AAM A214): document philosophical and operational requirements between instrumentation, equipment and process.

F.1.54 establish plant design basis* (AAM A16): the activity of collecting a complete and consistent set of constraints, requirements, and guidelines for subsequent engineering activities.

NOTE This activity results in the development of the design basis documents. See Design Basis.

F.1.55 evaluate bids and negotiate purchase* (AAM A33): the process whereby bid packages are evaluated, a supplier is selected, and an agreement is entered into for the acquisition of the plant item(s).

F.1.56 finalize layout, arrangement, and spatial design (AAM A242): develop the spatial design of the plant to its final approved-for-construction state utilizing the finalized system design as the primary input.

F.1.57 finalize system design (AAM A241): develop the system design, expressed by flow and control information and equipment performance data, to its final state.

NOTE The resulting design serves as a basis for detailed plant design.

F.1.58 guidelines and requirements: specifications, instructions, and mandates specified by management that shall be followed in the plant project. These guidelines and requirements may be project specific. Guidelines are more generally applicable than requirements, which tend to be specific in terms of what must be done.

NOTE - Originators and users of guidelines and requirements are:

- architectural and engineering;
- construction management;
- constructor;
- contractor (basic practices);

- engineering and construction;
- engineering, procurement, and construction;
- owner.

These categories are not mutually exclusive.

F.1.59 heat and mass calculations*: calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

F.1.60 identify and analyze safety requirements and hazards* (AAM A215): review design basis, unit operations, heat and mass balances, materials, identified equipment, control logic and process flow diagrams against federal, state and local regulations, codes and standards to determine compliance and produce an analysis of results.

F.1.61 identify and define unit operations* (AAM 211): incorporate the design basis and owner requirements to define and document the basis for conceptual process design and estimated time and cost expenditures. If the design activity is related to an existing plant, then existing operations are incorporated into the conceptual process design.

F.1.62 identify and size equipment* (AAM A213): identify equipment requirements based on the design basis and unit operations. Sizing of the equipment is based on the heat and mass balance calculations and unit operations.

F.1.63 identify plant performance requirements and establish design strategy (AAM A221): define a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period and describe the major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns.

NOTE Performance requirements are usually stated as units of product per unit time.

EXAMPLE Additional qualifications are typically made regarding the quality of the plant. Examples include time between major shutdowns for continuous processes, percent uptime required, and expected yield.

F.1.64 information databases: those elements of information collections comprising literature references, physical and transport properties, symbology sets, equipment specifications, and equipment costs that assist in the conception, design, construction, operation, and disposal of a process plant.

F.1.65 initial information: any knowledge available at the start of the process to build or modify a process plant.

EXAMPLE This includes information about the site, regulatory agreements, owner requirements, and approved suppliers.

F.1.66 innovation: new ideas and concepts generated internally or through the public domain to solve problems or to enhance the quality of work.

NOTE Some ideas and concepts may become goods, services, and systems that there is a societal requirement for. To some degree, innovation is fundamental to all activities involved with the process, however, particular emphasis is placed on activities that require generation of new ideas and concepts from abstract entities as inputs.

F.1.67 inspection plan*: the description of anticipated activities necessary for surveillance of suppliers, fabricators, and assemblers to verify compliance to contractual specifications, codes, and good practice.

NOTE The plan usually lists the items to be inspected, the place where the inspections are expected to occur, anticipated frequency of inspection and type of activity to be undertaken at each inspection. The reporting procedure for the surveillance results is usually included in the developed inspection plan.

F.1.68 inspection requirements*: requirements imposed by a regulatory agency related to the inspection of the plant during the decommissioning process.

F.1.69 inspection results*: reports that result from inspection and supplier surveillance activities.

F.1.70 layout plant (AAM A224): a general arrangement of the plant in plan view, showing all the major components of the distribution systems affected by the plant and the location of the plant. A general arrangement of all major equipment within the battery limits of the plant is also included.

F.1.71 licensed technologies: patented or proprietary processes or design information purchased or licensed from an outside source, such as a process processor, supplier, or fabricator.

NOTE This technology may range from laboratory synthesis data through unit operation process data to complete, detailed plant designs or equipment items and modules.

F.1.72 line schedule and list: a subset of information presented on the P&ID, and possibly the heat and mass balance, that describes the characteristics of pipelines required for a given process.

NOTE This information is used by the piping designer during the detail design. It is analogous to the equipment list.

F.1.73 maintain plant* (AAM A53): conduct and monitor the activities required to maintain the plant.

F.1.74 maintain suppliers list* (AAM A31): the process whereby a list of accepted or approved suppliers is kept up to date.

F.1.75 manage and plan project* (AAM A1): managing the project requires that sufficient resources be provided to execute the project and check that the execution is done in accordance with the plans and regulations. Planning the project is the activity that establishes a detailed technical plan and a financial plan that are consistent with the engineering, construction, and commissioning activities required to fulfill the project objectives.

F.1.76 manage plant* (AAM A51): direct and administrate the operations, maintenance, and disposal of the plant.

F.1.77 manage, operate, and maintain plant* (AAM A5): the activities required to manage, operate, and maintain the plant safely, efficiently, and according to operating procedures and regulations.

F.1.78 management authorizations and controls*: management authorization, imperatives, directives, and procedures for initiating and executing plant management activities.

F.1.79 obtain agreements with regulatory bodies* (AAM A15): the activity of confirming that the intended design, construction, commissioning, operation, and decommissioning of the proposed project will comply with requirements of the regulatory body. This confirmation is recorded by formal documentation such as written agreements and safety compliance reports.

F.1.80 obtain construction services* (AAM A42): use the construction plan as a requirements list for outside services needed and their schedule. Negotiate contracts and agreements with sub-contractors, equipment suppliers, and labour unions as needed for the erection of the plant. Adjust the schedule of the construction plan to allow for the availability of sub-contractors, equipment and labour.

F.1.81 operate plant* (AAM A52): conduct and monitor the activities required to operate the plant.

F.1.82 operating philosophy*: the plant owner's operational goals.

EXAMPLE Operational goals include methods of production, technology, plant safety, and plant availability.

F.1.83 operating procedures*: documentation that covers many different phases and aspects of plant operation that is necessary to run the plant safely.

F.1.84 optimize for environment* (AAM A236): evaluate the plant design against the applicable environmental regulations (Federal, State, and local) and modify the design where required.

NOTE These regulations influence many of the activities in plant and process design such as operating procedures, plant and process control strategies, specification and design of piping, instrumentation, and equipment, as well as site selection. Broad regulatory interpretations often mean that conservative measures are incorporated in plant design.

F.1.85 owner requirements: an initial statement of plant requirements provided by the owner.

NOTE Owner requirements are an aggregation of items such as design requirements and client general specifications. The owner requirements may be provided at any level of abstraction from very general to very specific.

F.1.86 perform process plant life-cycle activities (AAM A0): the completion of all tasks involved in the life cycle of a process plant from conception through final disposal.

NOTE 1 These tasks include:

- conception;
- research;
- design;
- construction;
- operation;
- maintenance;
- retrofit;
- disposal.

NOTE 2 Major outputs from the life-cycle activities are contractual documents, regulatory compliance information, data retained beyond the life time of the plant, useful products generated by the operation of the plant, and residual materials remaining in the environment upon completion of the plant life cycle. These residual materials include waste products generated while producing the product(s) and the disassembled plant.

F.1.87 personnel*: the individuals responsible for performing the life-cycle activities of the process plant.

EXAMPLE These individuals include discipline experts, skilled workers, and labourers.

F.1.88 piping and instrumentation diagram (P&ID): a schematic diagram that shows engineering details of the equipment, instruments, pipes, valves, and their connectivity and sequence.

F.1.89 piping and instrumentation diagram (AFD): the process definition is firm. Instrumentation needs to be added.

F.1.90 piping and instrumentation diagram (design): instrumentation details are included. All lines and valves have been sized. All valving, vents and drains are included. Instrumentation and loops are indicated, but final instrumentation may not have been selected.

F.1.91 piping and instrumentation diagram (final): the complete P&ID has been approved for release by engineering for construction and has been stamped by a registered professional engineer. It is a last version of the design P&ID. It contains all changes that were incorporated during the physical design of the systems. It reflects the plant as it was, or will be, constructed.

F.1.92 piping and instrumentation diagram (preliminary): conveys the flow of the fluids from equipment to equipment in the system. It shows the valves that are used to control the flow. The major fluid containing lines have been sized.

F.1.93 plan and analyze project finances* (AAM A14): the activity of anticipating and estimating the financial resource requirements for a project. This activity establishes the expected financial performance for the project and the project financial plan.

F.1.94 plant: a portion of an installation (or the entire installation) required to operate to produce products.

EXAMPLE Products produced include chemicals, pharmaceuticals, electrical power, petroleum, and similar products.

F.1.95 plant design documentation: all documents related to the process of designing the process plant.

NOTE Plant design documents include the approved design methodologies, basic data describing physical properties and their correlations used in the design, kinetic data and kinetic models used in the design, corrosion data and methodology used in selecting materials of construction, supplier performance data, capital and operating cost estimates, and appropriations requests.

F.1.96 plant items: an item or piece of equipment that may be used as a component of the plant.

F.1.97 plant life-cycle documentation: the collection of all project management, design, contractual, regulatory, and disposal documents produced during the life cycle of a process plant.

NOTE This includes all data retained past the end of the plant life cycle.

F.1.98 plant operation and maintenance documentation*: the collection of documents relating to the operation and maintenance of process plant.

NOTE These documents include operating records and plant data, safety and accident reports, maintenance reports, disposal records for all residual materials generated during the operation of the plant, and economic information related to product sales.

F.1.99 plant performance requirements: a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period.

NOTE Performance requirements are usually stated as units of product per unit time. Additional qualifications are made regarding the quality of the Plant, such as time between major shutdowns for continuous processes, percent uptime required, and expected yield.

F.1.100 plant records*: the documentation of information related to plant disposal, restoration, turnover, and regulatory approvals.

F.1.101 pre-commission plant* (AAM A45): resolve any differences between the detailed design and the as-built plant, perform all testing required by regulatory agencies and the client, resolve any problems that were discovered during testing, and obtain regulatory permission to start-up the plant for functional testing.

F.1.102 pre-commissioned plant*: a plant that is completed and ready for check out. Mechanical systems are complete, transfer of ownership and operation remain.

F.1.103 prepare bid packages and solicit bids* (AAM A32): the process whereby the technical and commercial requirements for a plant item are compiled and sent out for pricing by multiple suppliers.

F.1.104 process control logic*: prose or diagrammatic explanation of mechanisms or systems that monitor and control a process.

F.1.105 process control logic (preliminary)*: initial prose or diagrammatic explanation of mechanisms or systems that monitor and control a process developed during conceptual process design.

F.1.106 process flow diagram (PFD): a schematic document describing the equipment units and their interconnections, major process control functions, and major stream characteristics including physical and transport properties, material flows, and energy flows.

F.1.107 procure goods and services* (AAM A3): the process whereby needed plant items, equipment, or services are purchased or acquired.

F.1.108 procured item*: plant item that has been obtained from a supplier for incorporation into the plant.

NOTE States or status of procured items include:

- in_fabrication;
- accepted;
- shipped;
- delivered_to_site.

F.1.109 produce as-built surveys* (AAM A44): the completed plant is given a physical inspection to determine whether the plant conforms to the detailed design. The detail design drawings and other documents are updated to reflect the changes to the plant discovered during the inspection.

F.1.110 produce conceptual plant design (AAM A22): the activity of extending the conceptual process design into a preliminary plant spatial configuration.

F.1.111 produce conceptual process design* (AAM A21): the activity of defining the basic parameters of a plant flow scheme.

F.1.112 produce conceptual safety engineering designs (AAM A225): create designs that specifically address how the major hazards associated with the new plant are to be dealt with to ensure the safety of all personnel working in the plant as well as the general site and surrounding neighborhood population.

NOTE These hazards will have been identified during the preliminary screening reviews to identify chemical, fire and health hazards associated with the specific chemical or mechanical characteristics of the process.

F.1.113 produce construction plans* (AAM A41): using site drawings, layout drawings, and other documents, determine the desired sequence for building the plant that will meet contract budget and schedule. Determine those services that will be needed from sub-contractors for the site preparation, erection, and testing of the plant. Develop detailed erection drawings and schedules for each section of the plant and for temporary structures.

F.1.114 produce final plant design (AAM A24): the activities required to generate a construction design specification from the process plant requirements.

NOTE The activities include designing the mechanical, electrical, and civil engineering systems of the process, designing the detailed instrumentation systems, producing piping and instrumentation diagrams and detailed equipment layout through isometric drawings or three-dimensional computer-aided design (CAD) models.

F.1.115 produce final process design* (AAM A23): integration of conceptual process and plant designs to fully define parameters of a plant flow scheme.

F.1.116 produce process flow diagrams* (AAM A216): production of a schematic showing basic process flow developed from the cumulative results of unit operations, equipment sizing, initial logic and safety requirements along with related chemical properties.

NOTE If a design activity is related to a modification or addition to an existing plant, then the existing plant information is reflected in the developed process flow diagram.

F.1.117 project authorizations and controls*: management authorization, imperatives, directives, and procedures for initiating and executing project activities.

F.1.118 project control and approval documentation: a set of documents that define the standard procedures, standard software modules, or standard forms adopted to ensure that all activities in the project comply with organizational constraints. The documents indicate how all activities are to be implemented and approved and identify all constraints that must be met.

NOTE The constraints include financial limitations, accounting, legal and regulatory restrictions, socio-economic factors, and business practices throughout the plant life cycle.

F.1.119 project financial plan*: document that states how much the plant will cost to construct, how it is to be paid for, and when payments are to be made. It is a general financing and cash flow document.

F.1.120 project-specific documents: procedures, standards, guidelines, specifications, and codes created specifically for the plant project. These documents may call out, add to, modify, or tailor a standard. Portions of these documents are derived from the design basis.

NOTE Project-specific documents evolve through stages like P&IDs and other design documentation.

F.1.121 provide resources* (AAM A12): acquire and deploy personnel, tools, and funding to perform the project activities.

F.1.122 purchase agreement*: contract between two parties to provide a service or item for a designated payment.

F.1.123 qualified construction firms*: list of construction firms that are capable and acceptable to construct the plant.

F.1.124 receive, inspect, and disposition components* (AAM A34): the process of receiving equipment and materials from various suppliers at the process plant, inspecting the equipment and

material for compliance to the purchase specification, and either placing the equipment or material in stock, delivering it to construction or maintenance, or returning it to the supplier.

F.1.125 regulatory agreements*: mutual agreement between the owner or operators and regulatory agencies.

F.1.126 regulatory authorizations*: approval from regulatory agencies to initiate activities.

F.1.127 regulatory requirements: federal, state, or local laws, codes, or standards that impact various activities related to the process plant.

NOTE Regulatory requirements may apply to, but are not limited to, permitting, engineering, construction, operations and decommissioning.

F.1.128 request for management approval: a document submitted to management requesting either approval to continue a particular activity of the project or requesting the procedure to use to solve a particular problem.

NOTE Approval requests may, at times, include a request that the company appropriate monies for a particular activity.

F.1.129 residual materials*: all chemicals and equipment, excluding useful products, remaining in the environment at the end of the plant life cycle.

F.1.130 resources*: the technology, people, and tools used to carry out the plant life-cycle activities.

F.1.131 resources (existing)*: currently available technology, people, and tools used to carry out the plant life-cycle activities.

F.1.132 safety and hazardous operations analysis*: the results of the evaluation of the plant design with respect to safety and hazardous operations. Identifies possible causes of faults and their consequences, and recommends remedies.

F.1.133 safety and hazardous operations analysis (preliminary)*: the initial results of the evaluation of the plant design with respect to safety and hazardous operations.

F.1.134 safety compliance reports*: documentation of analyses and evaluations of the plant performed with respect to safety considerations.

F.1.135 safety system specification: job specific document related to plant safety.

NOTE This specification may be developed from applying the design safety philosophy to plant design.

F.1.136 satisfy safety requirements* (AAM A235): perform a formal plant process design, operation, and control review to assess the whether all safety requirements are met.

NOTE Plant safety requirements involve issues such as source terms for spill scenarios, vapour dispersion for combustible and toxic releases, reliability of metallurgy and other materials, component failure rates, operator response and error, fail-safe instrumentation, equipment spacing, number and size of equipment trains, radiation from fires, relief system design philosophies, deflagration test results, thermal runaways and associated vent sizing, detonations and resulting shock waves.

F.1.137 schedules*: a time-based list of project tasks that describes:

- what is supposed to happen;
- when it is supposed to happen;
- task sequence and dependencies;
- restraints and constraints;
- float;
- critical path.

F.1.138 schematic diagrams*: a physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information.

EXAMPLE Types of schematic diagrams include:

- PFD;
- P&ID;
- electrical single line;
- motor control;
- control loops;
- HVAC;
- plumbing;
- input output.

NOTE Schematic diagrams evolve through stages like P&IDs and other design documentation.

F.1.139 schematic diagrams (preliminary)*: an initial physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information developed during conceptual plant design.

F.1.140 site information (existing): information about the physical location where the plant will be constructed and the conditions of any plant on the site (if one exists).

EXAMPLE Site information includes:

- geological data, such as before and after terrain contours, and subterranean structure, and seismic activity;

- meteorological data such as seasonal wind profile, precipitation, snowfall, and ambient temperature;
- road data;
- cadastre (property lines) zones;
- utilities.

NOTE A kind of site information included in the scope of this part of ISO 10303 is verified field dimensions. They are parameters that specify the physical and spatial characteristics of an existing item or component in a plant that have been verified by measurements taken by a second, independent agency. For example, field dimensions provided by the Plant owner for piping tie-in locations (coordinate locations and sizes) are considered as "verified" when duplicated by the AEC representative. If discrepancies are discovered during verification of the field dimensions, the initial and verification measurement processes must be repeated to assure verified dimensions.

NOTE Existing plant conditions are the characteristics of the existing plant(s) relevant to the revamp, retrofit, or expansion Plant project.

F.1.141 societal requirements*: the expressed need or demand by society, on either a local, national, or global scale, for products, services, or processes.

NOTE In some instances, a market study may project the expected demand or price of a product or service required by some element of society.

F.1.142 specifications and standards: consensus or mandated technical descriptions of plant hardware or systems that control the design or construction of a plant.

F.1.143 specify building and plant services (AAM A243): establish utility and other service needs for the building(s) and plant(s) based on owner requirements, final system design, and final spatial design.

F.1.144 specify control requirements* (AAM A234): define instrumentation and control system characteristics required to fulfill requirements for plant operation using the operating procedures and safety requirements.

NOTE Control systems are used to help maintain plant safety, ensure product quality, and to safeguard equipment. These systems are used to control areas such as process reactions, flows, temperatures, pressures, and levels. They operate automatically, or provide indications to plant personnel. Control requirements are generally defined in the operating procedures and specified on the P&ID and in the instrument list.

F.1.145 specify equipment functional characteristics* (AAM A233): define the functional characteristics of each major item of equipment based on confirmed plant operating requirements, process technologies, and process optimization.

EXAMPLE Functional characteristics include equipment type, process stream inputs, outputs, capacities, and conditions, equipment metallurgy, piping and instrumentation, power requirements, and auxiliary systems.

F.1.146 specify piping and instrumentation* (AAM A232): define piping and instrumentation required by the process plant based on the functional requirements for the plant.

NOTE Piping and instrumentation functional requirements are developed based on plant production capacities, process type or technology, control methodology, chemical content of process streams, and equipment layout. Also considered are alternative operating conditions, maintenance requirements, and plant operating and personal safety are issues. The results of this activity are detailed on P&IDs, line lists, equipment lists, and instrument lists.

F.1.147 starting materials*: all necessary equipment components or consumable goods necessary to construct and operate the process plant for the production of useful products.

F.1.148 status: a report of the current state of a task, design, action, or schedule. It is a quality assurance feedback mechanism.

F.1.149 stream data: chemical composition, physical state, and mass quantities of process flows.

F.1.150 supplier documentation: drawings, manuals, calculations, etc. received from a company concerning items procured from the company, that provides information concerning design details or performance of the procured items.

NOTE - Statuses assigned to supplier documentation include:

- preliminary (in-process design information);
- certified (information from the supplier is warranted to correctly describe the as-delivered functional or physical data);
- released for fabrication or construction.

F.1.151 suppliers list*: a list of companies that provide commodities or services to an organization.

NOTE - Kinds or statuses of supplier lists include:

- approved;
- recommended;
- partnered.

F.1.152 system design (preliminary): at the conceptual level, this is an initial definition and representation of the physical components or items of the system.

F.1.153 system layout (preliminary): at the conceptual level, this is an initial definition and representation of the spatial configuration or arrangement of the system, showing all the major components of the system.

F.1.154 system layout and design: the definition and representation of the physical components or items and spatial configuration of the system in sufficient detail to support construction.

NOTE 1 This definition results from the use of the system design basis, P&IDs, specifications, and other documentation or information.

NOTE 2 The definition of the term "system" is broader than common usage, e.g., it encompasses structural systems.

NOTE 3 System layout and designs can be viewed or categorized according to the following breakdowns:

— evolutionary phase

- a) Initial;
- b) Design;
- c) Final.

— system type

- a) Piping;
- b) HVAC;
- c) Electrical;
- d) Instrumentation and Control;
- e) Structural and Civil;
- f) Architecture;
- g) Safety.

— functional views

- a) Conceptual arrangement;
- b) Spatial information;
- c) Schematic diagram;
- d) Piping and instrumentation diagram (includes piping connectivity and sequencing).

EXAMPLE The final HVAC spatial information system design and layout will specify the definition, physical dimensions, location coordinates, and characteristics for all HVAC components that occupy space in the Plant. Only those physical dimensions, location coordinates, and characteristics required to specify the spatial instance of each component are included in this definition.

F.1.155 system layout and design (preliminary): the initial definition and representation of the physical components or items and spatial configuration of the system.

F.1.156 time and cost estimate*: projected or forecasted cost and length of time to design, produce, or procure a plant item, obtain a service, or achieve some goal.

F.1.157 unit operations*: design basis and owner requirements that define the basis for conceptual process design.

F.1.158 useful products*: the materials or energy generated through the operation of the process plant that are sold to customers for a profit.

F.2 Application activity model diagrams

The application activity model diagrams are given in figures F.2 through F.23. The graphical form of the application activity model is presented in the IDEF0 activity modelling format. Activities and data flows that are out of scope are marked with asterisks.

Figure F.1 describes the basic notation used in IDEF0 modelling. Each activity may be decomposed to provide more detail. If an activity has been decomposed, a separate diagram is included.

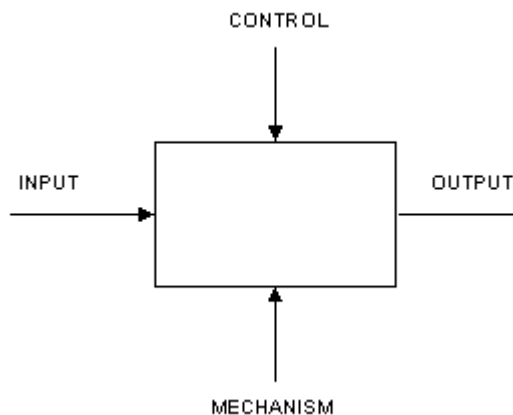
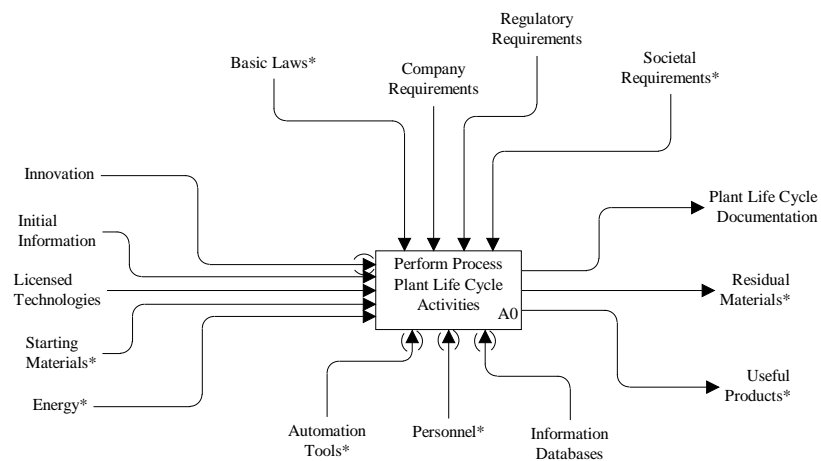


Figure F.1 - IDEF0 basic notation

As with any IDEF0 model, the AAM is dependent on a particular viewpoint and purpose. The purpose of the AAM is to describe the exchange of process plant spatial configuration information and design, fabrication, and maintenance information for process plant piping systems.



PURPOSE: To describe the exchange of process plant spatial configuration information and design, fabrication, and maintenance information for process plant systems.

VIEWPOINT: The user(s) of plant spatial configuration information, including architects, engineers, fabricators and constructors.

Figure F.2 - A-0: Process Plants

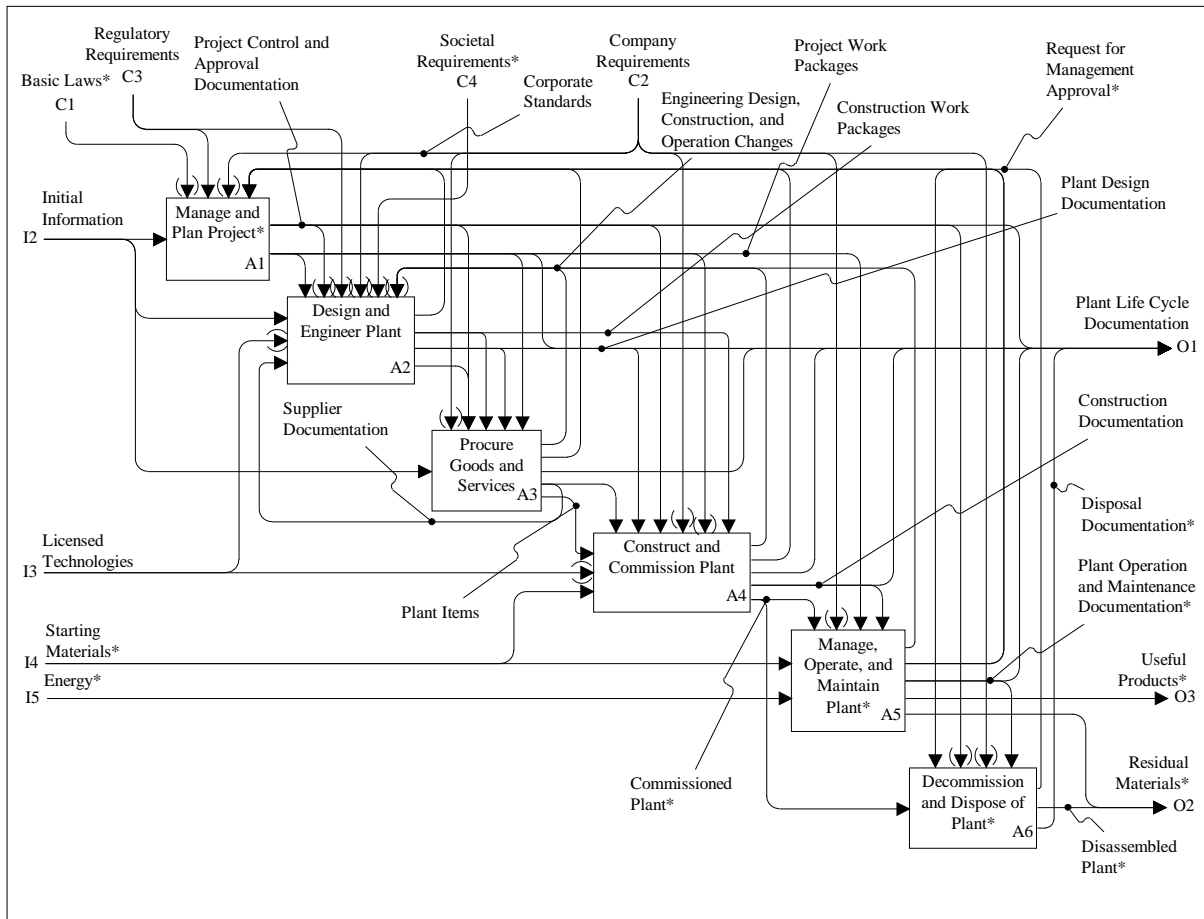


Figure F.3 - A0: Perform Process Plant Life-cycle Activities

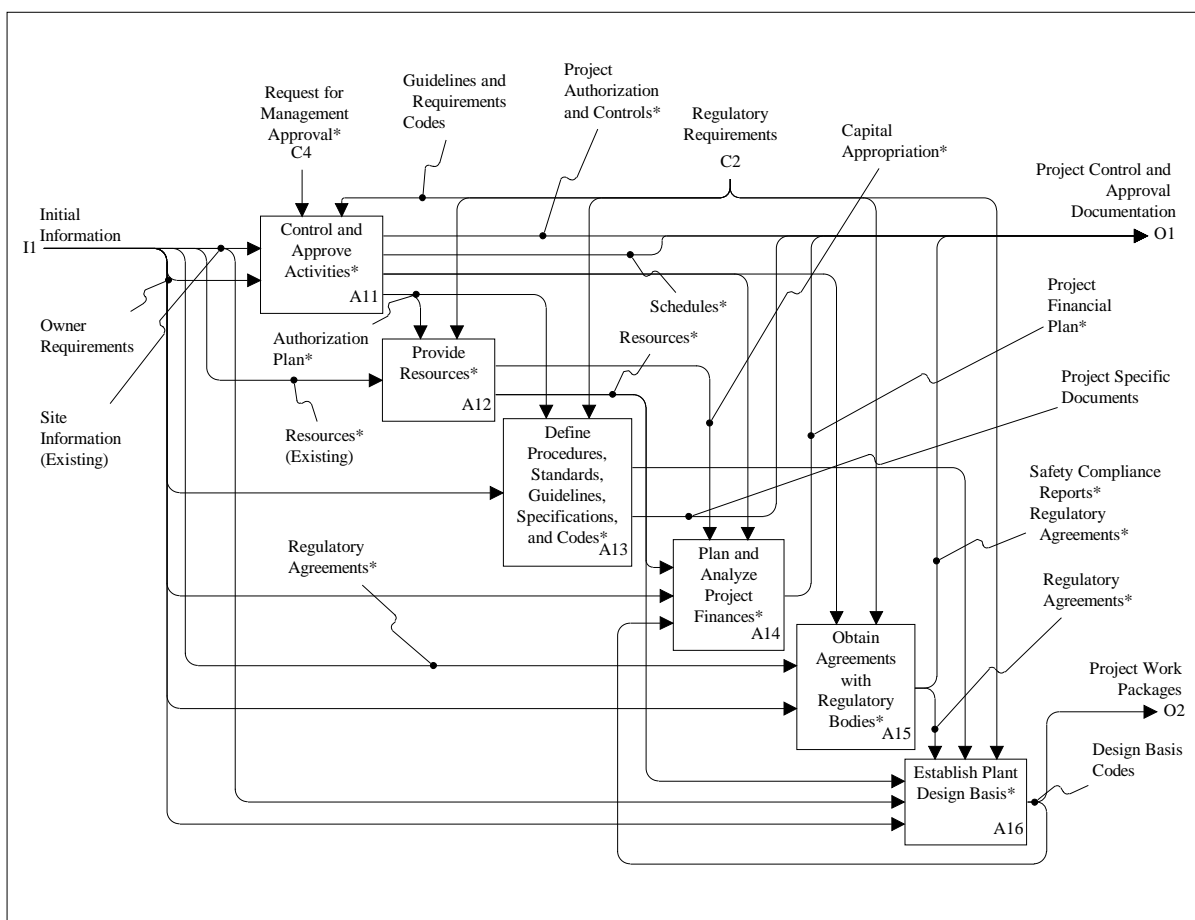


Figure F.4 - A1: Manage and Plan Project

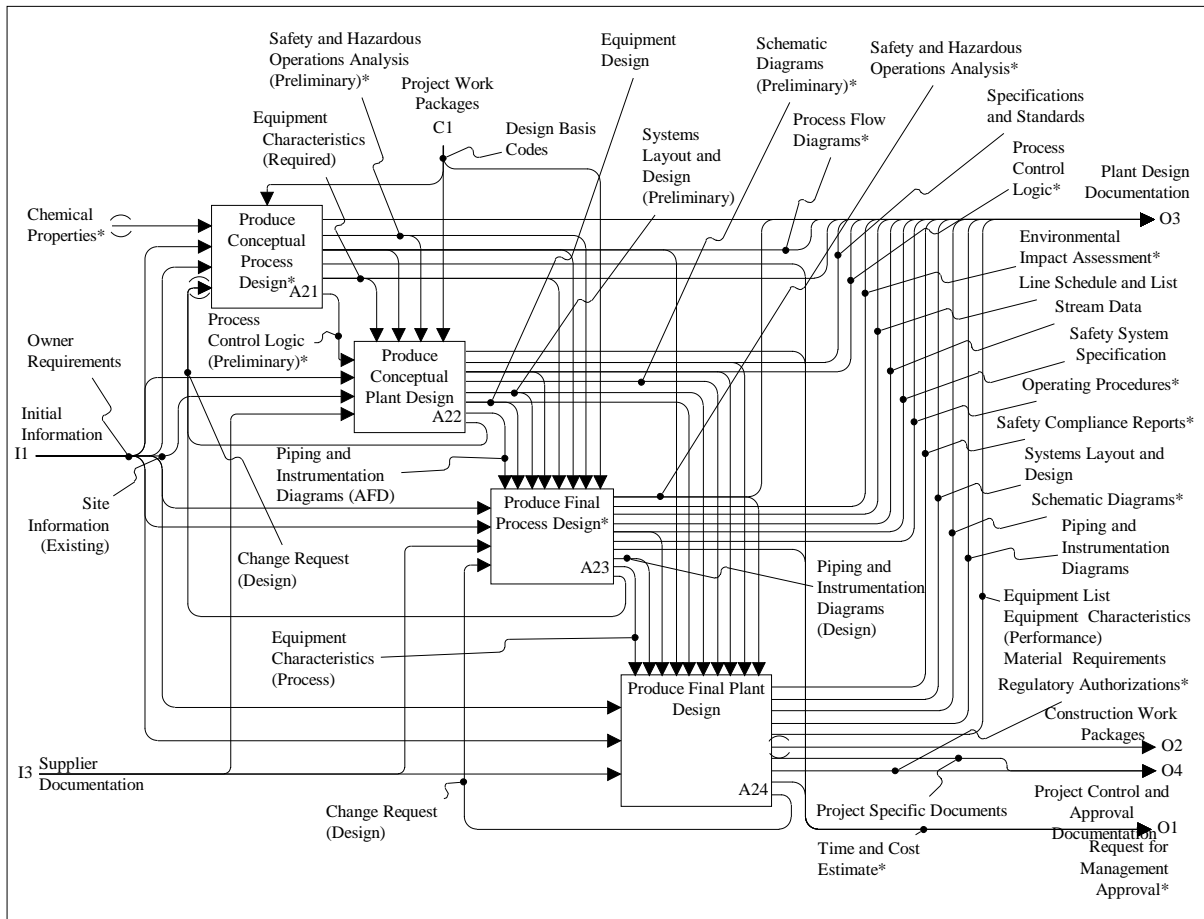


Figure F.5 - A2: Design and Engineer Plant

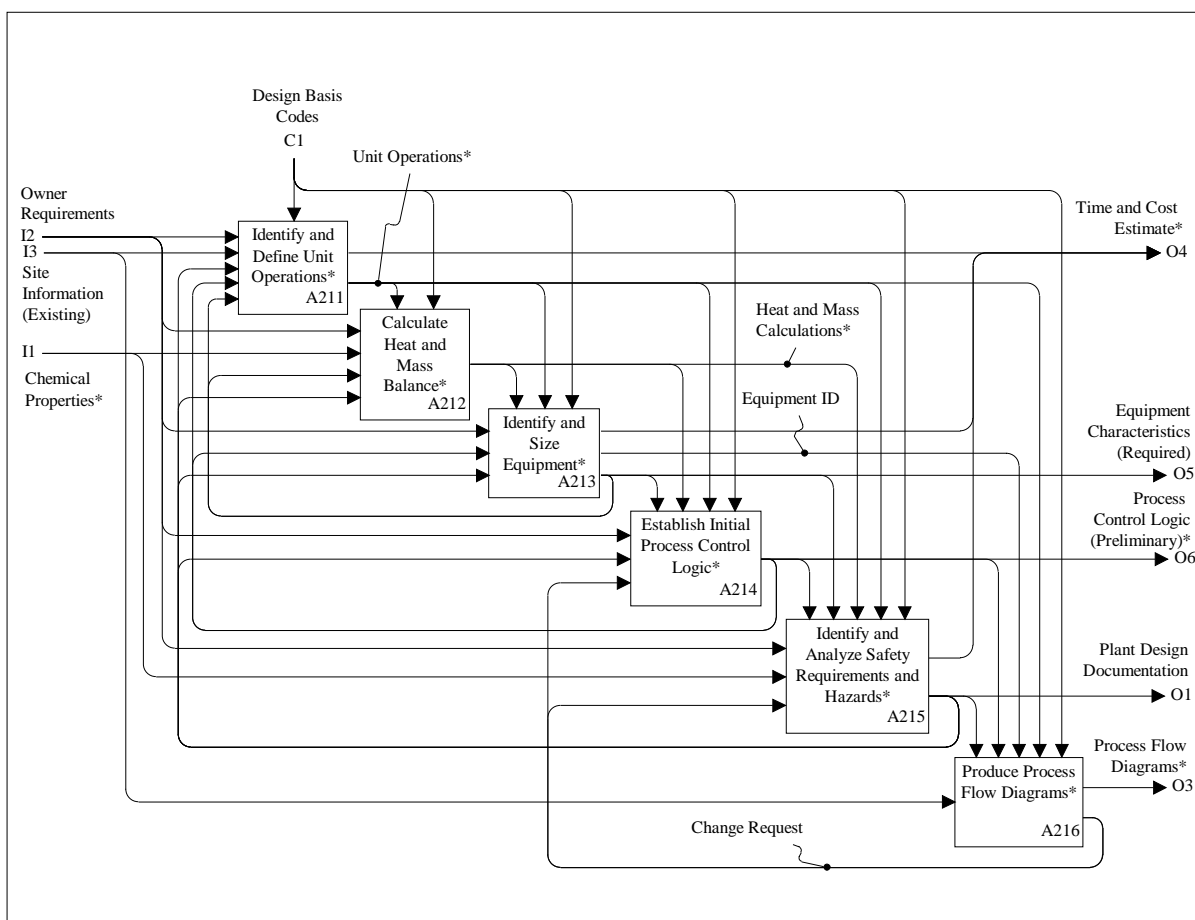


Figure F.6 - A21: Produce Conceptual Process Design

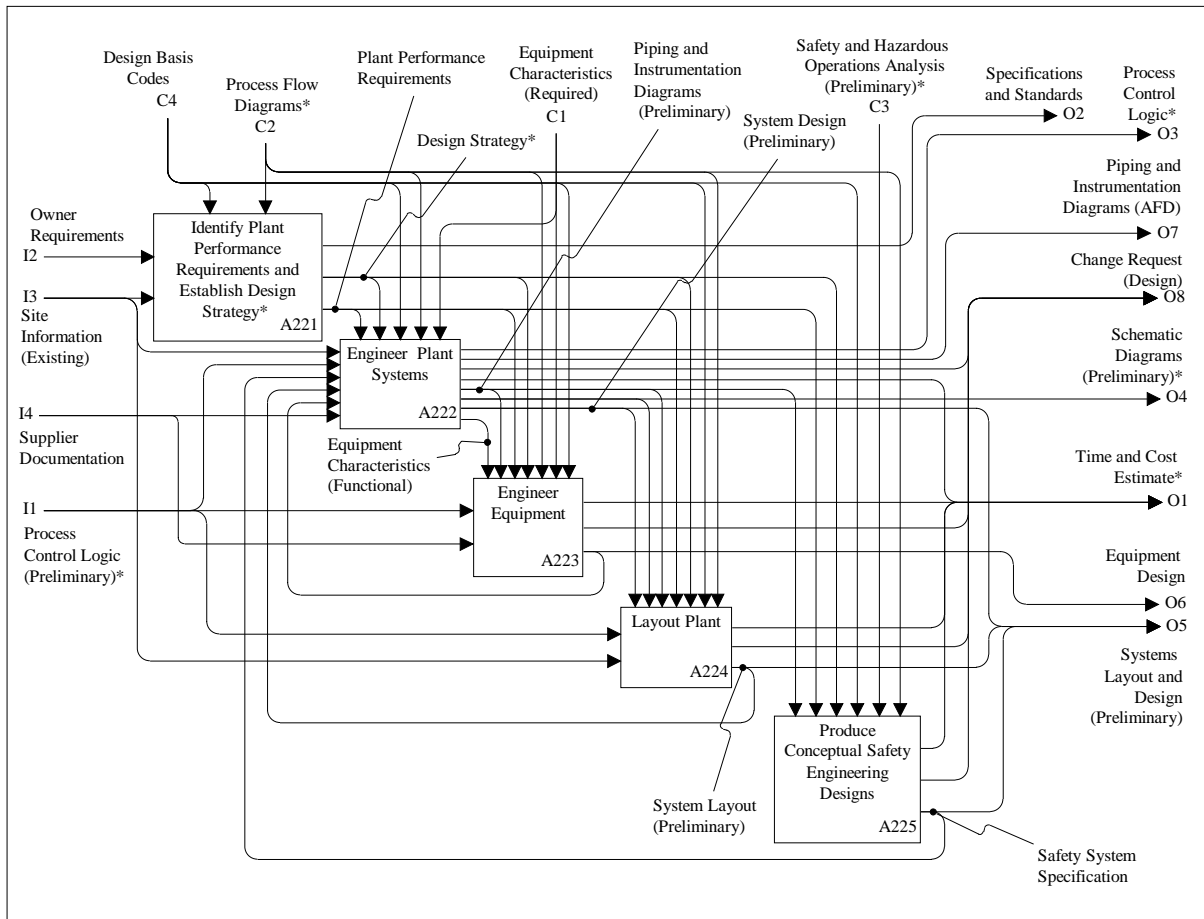


Figure F.7 - A22: Produce Conceptual Plant Design

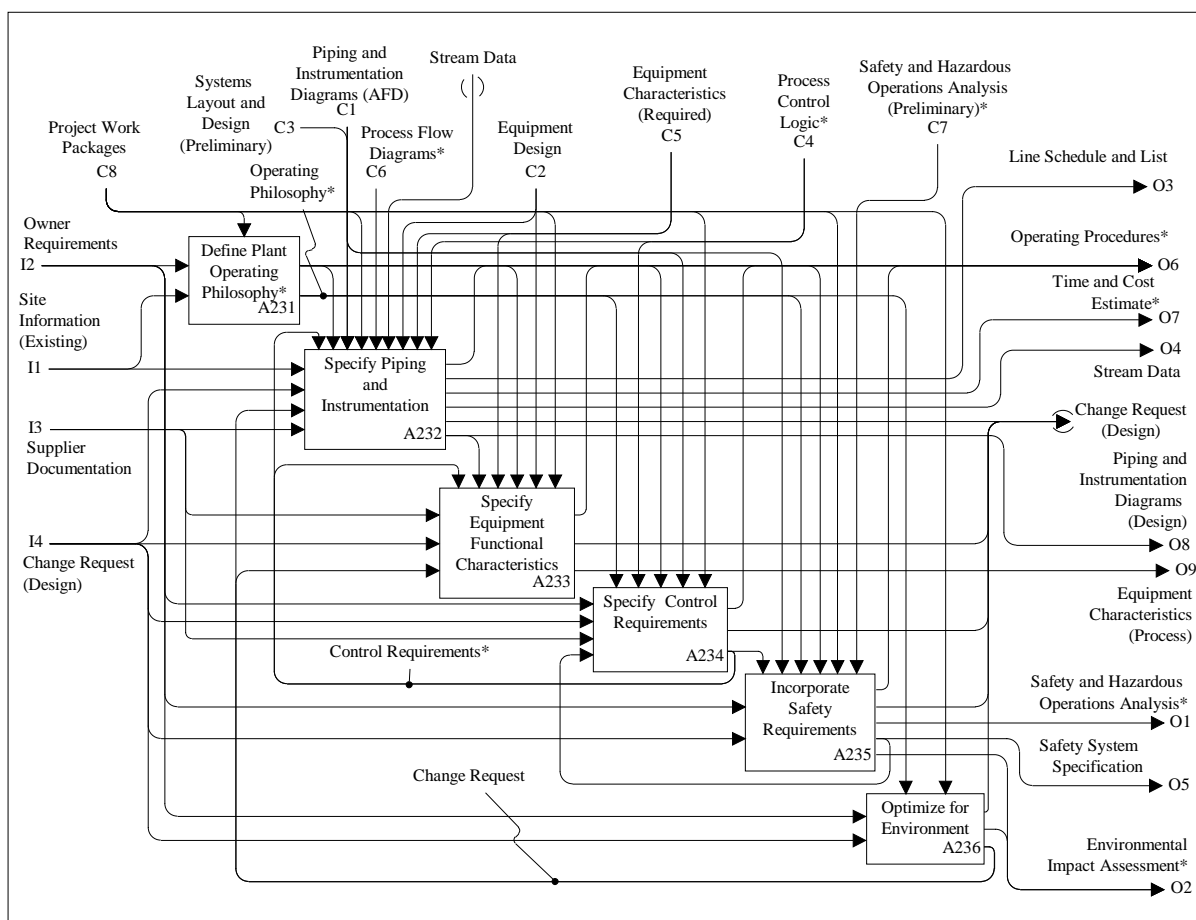


Figure F.8 - A23: Produce Final Process Design

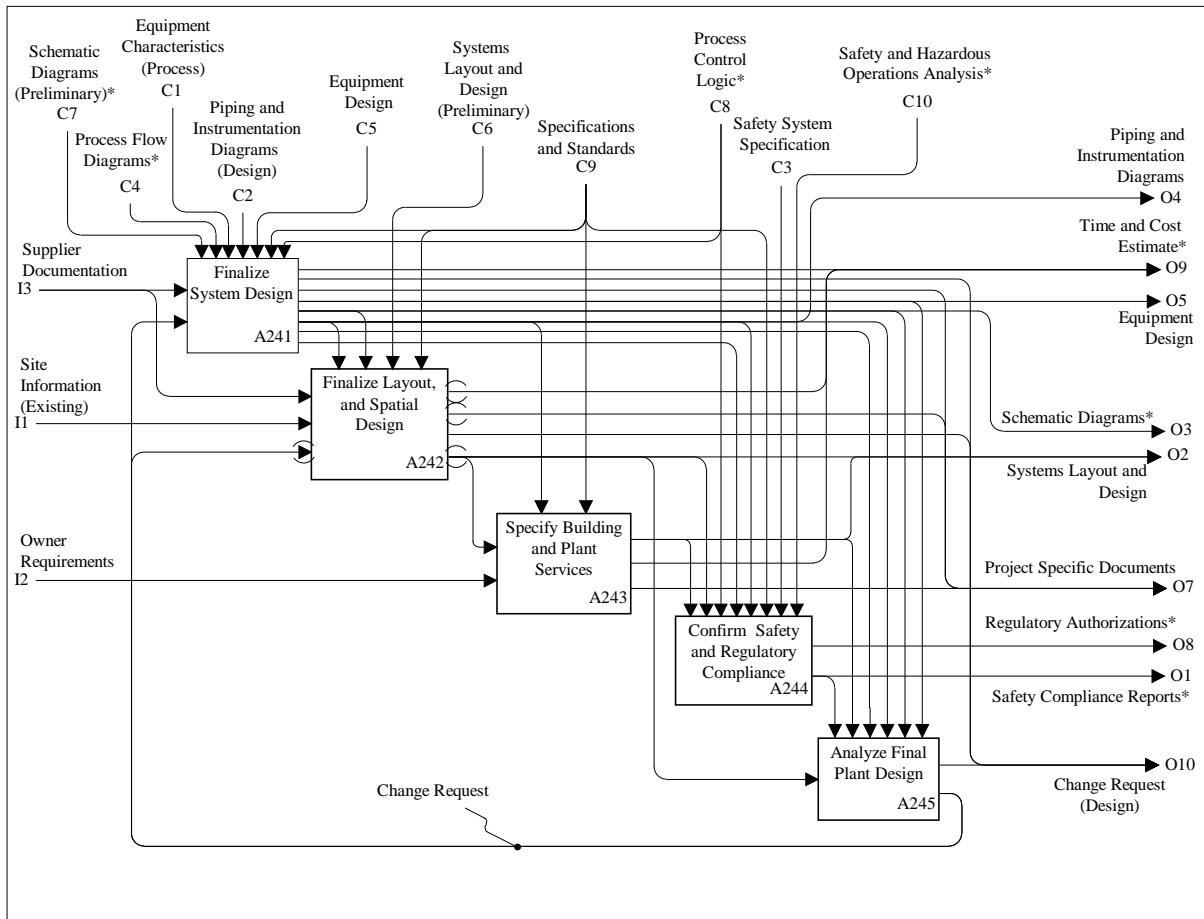


Figure F.9 - A24: Produce Final Plant Design

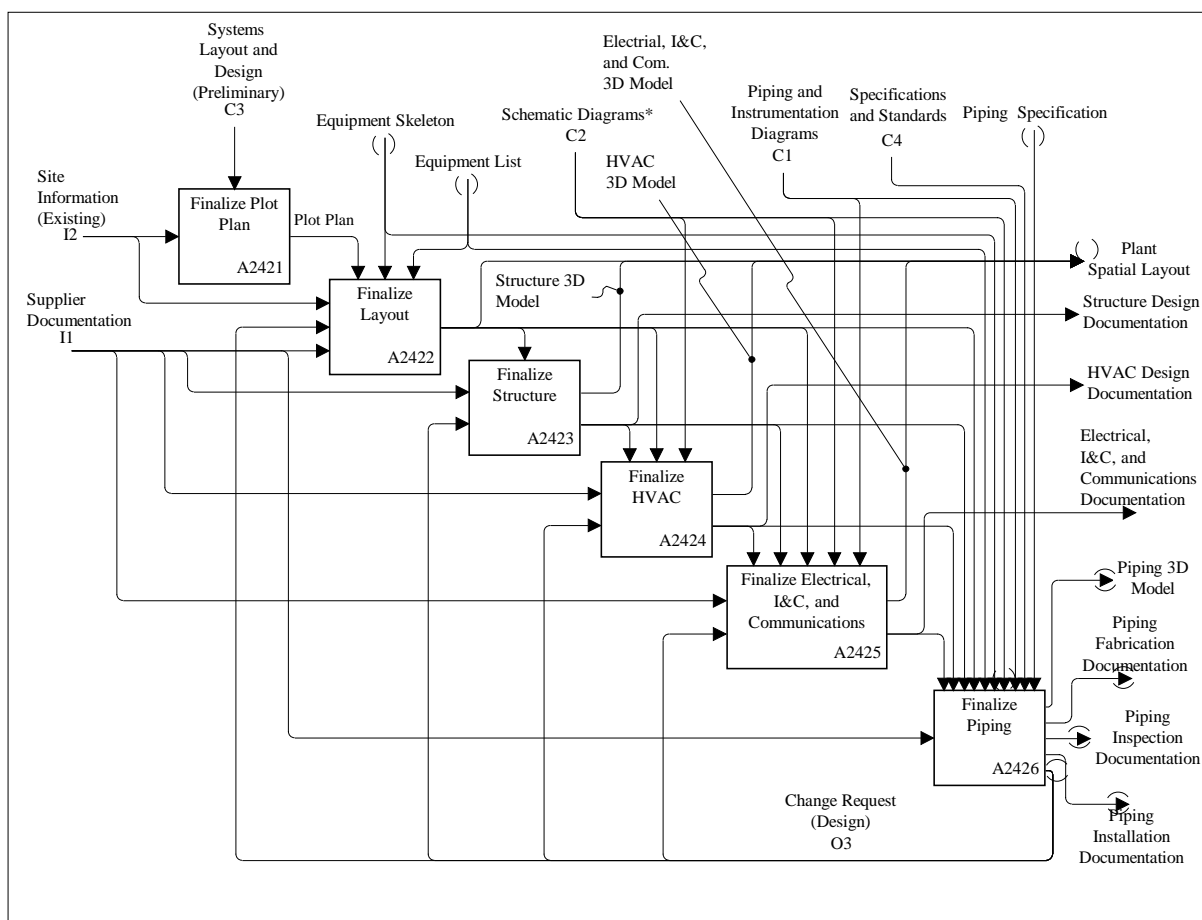


Figure F.10 - A242: Finalize Layout and Spatial Design

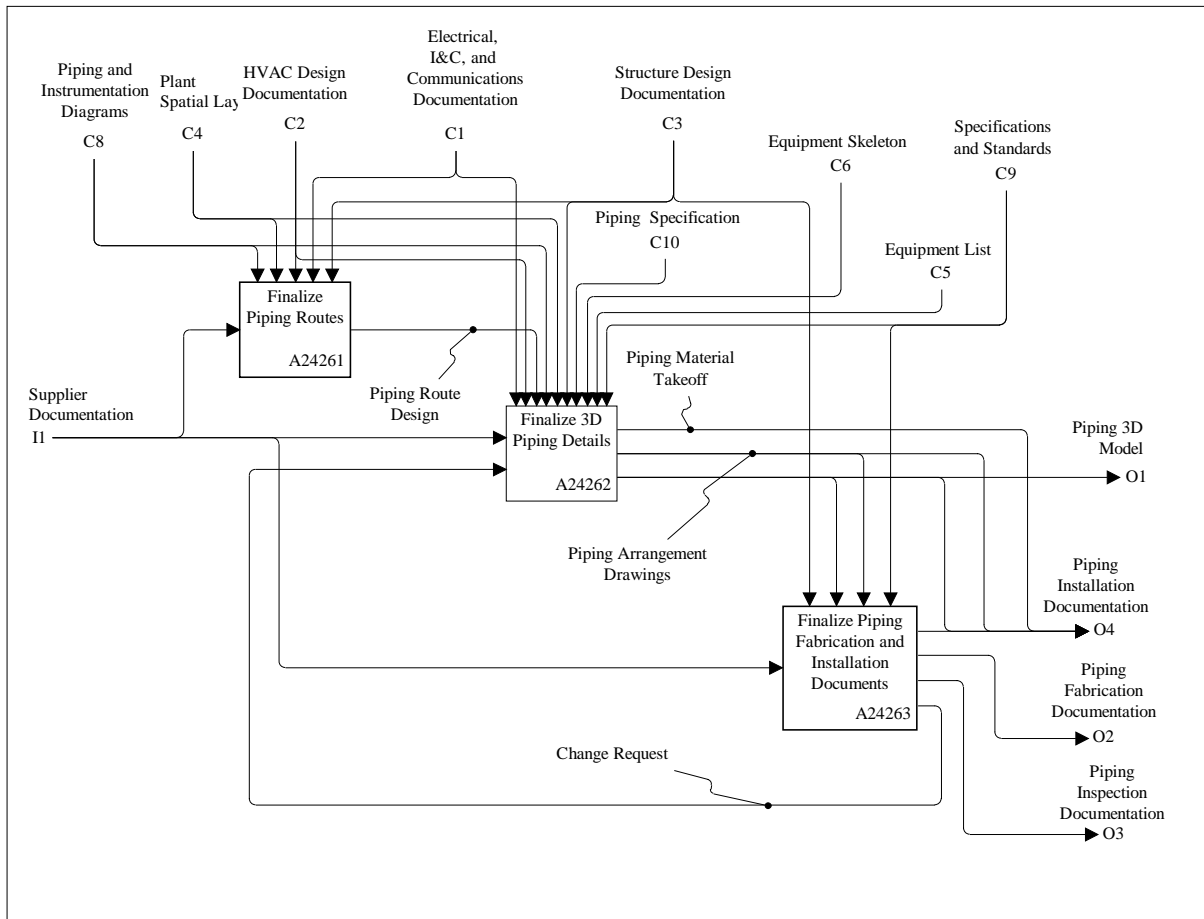


Figure F.11 - A2426: Finalize Piping

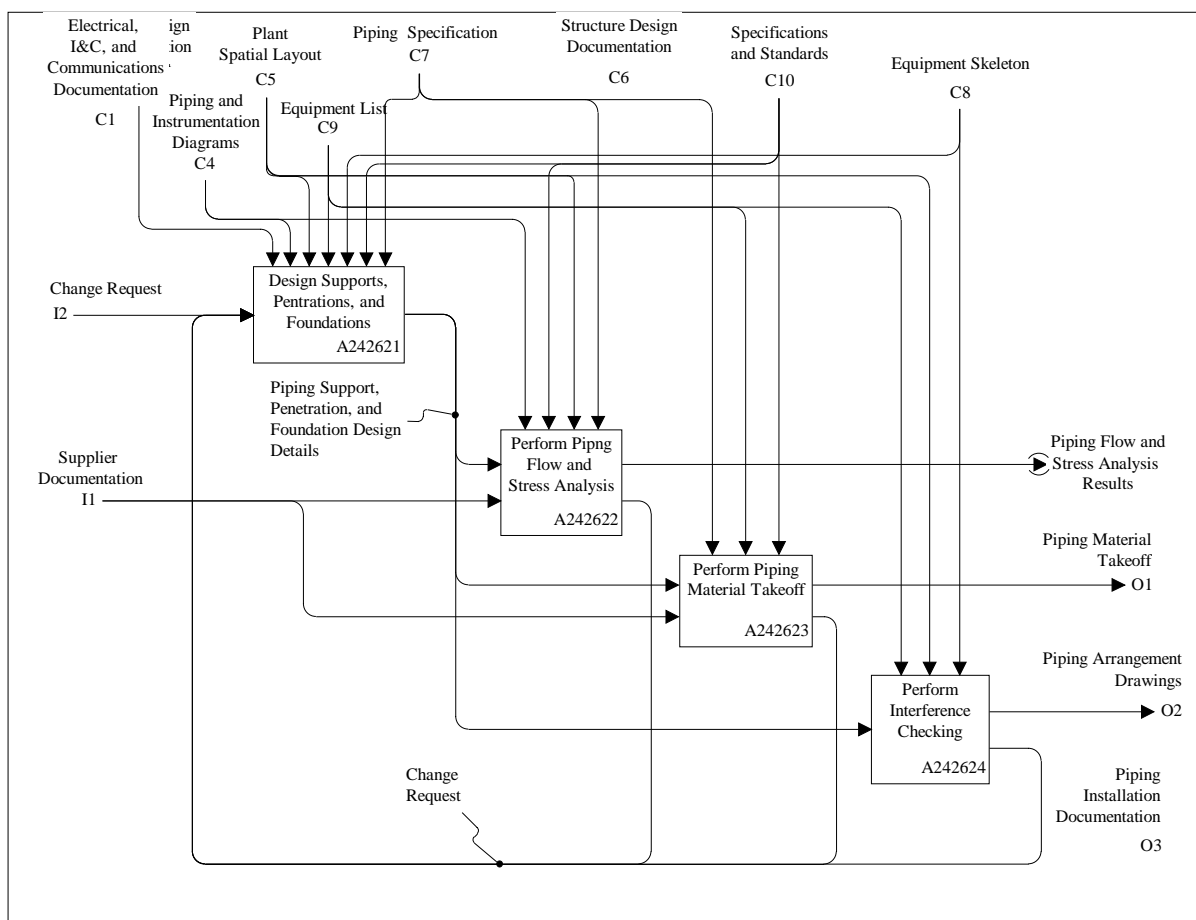


Figure F.12 - A24262: Finalize 3D Piping Details

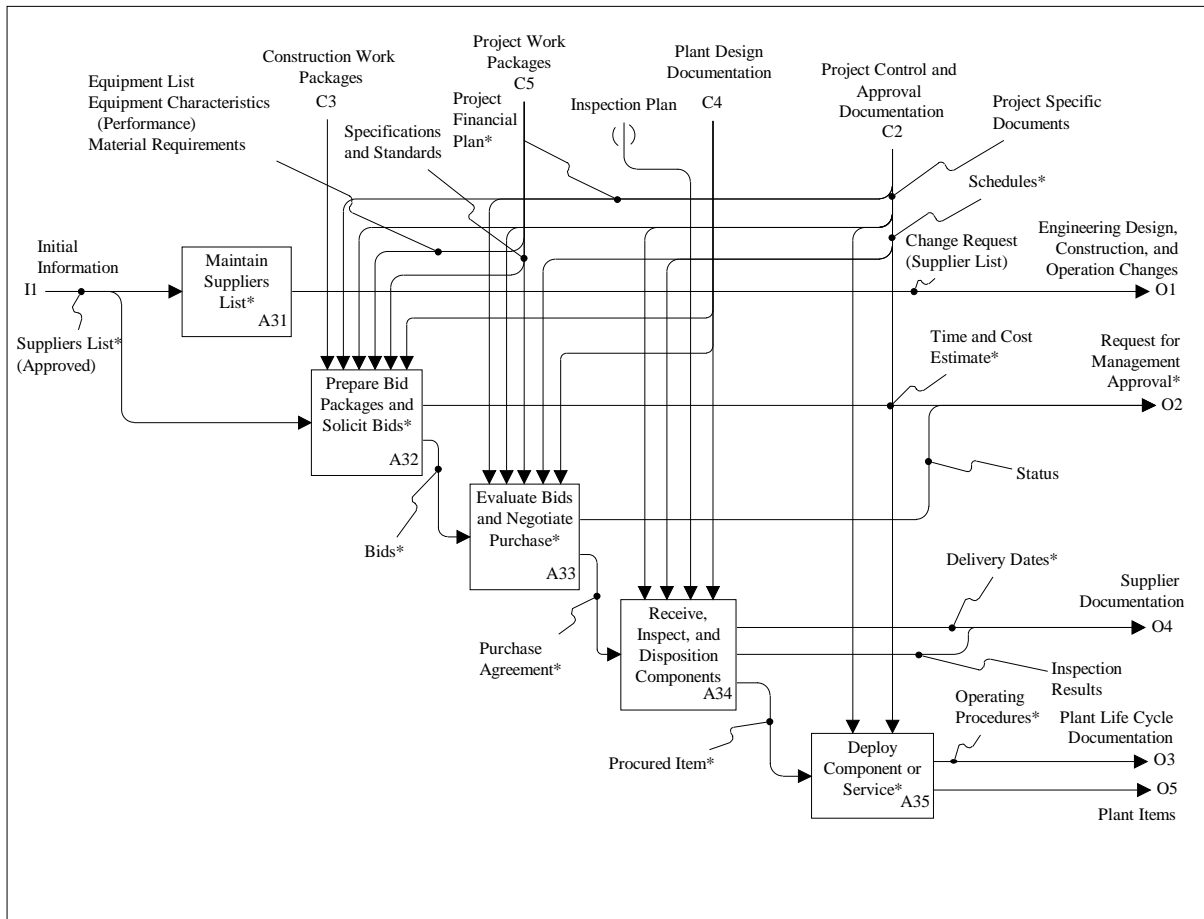


Figure F.13 - A3: Procure Goods and Services

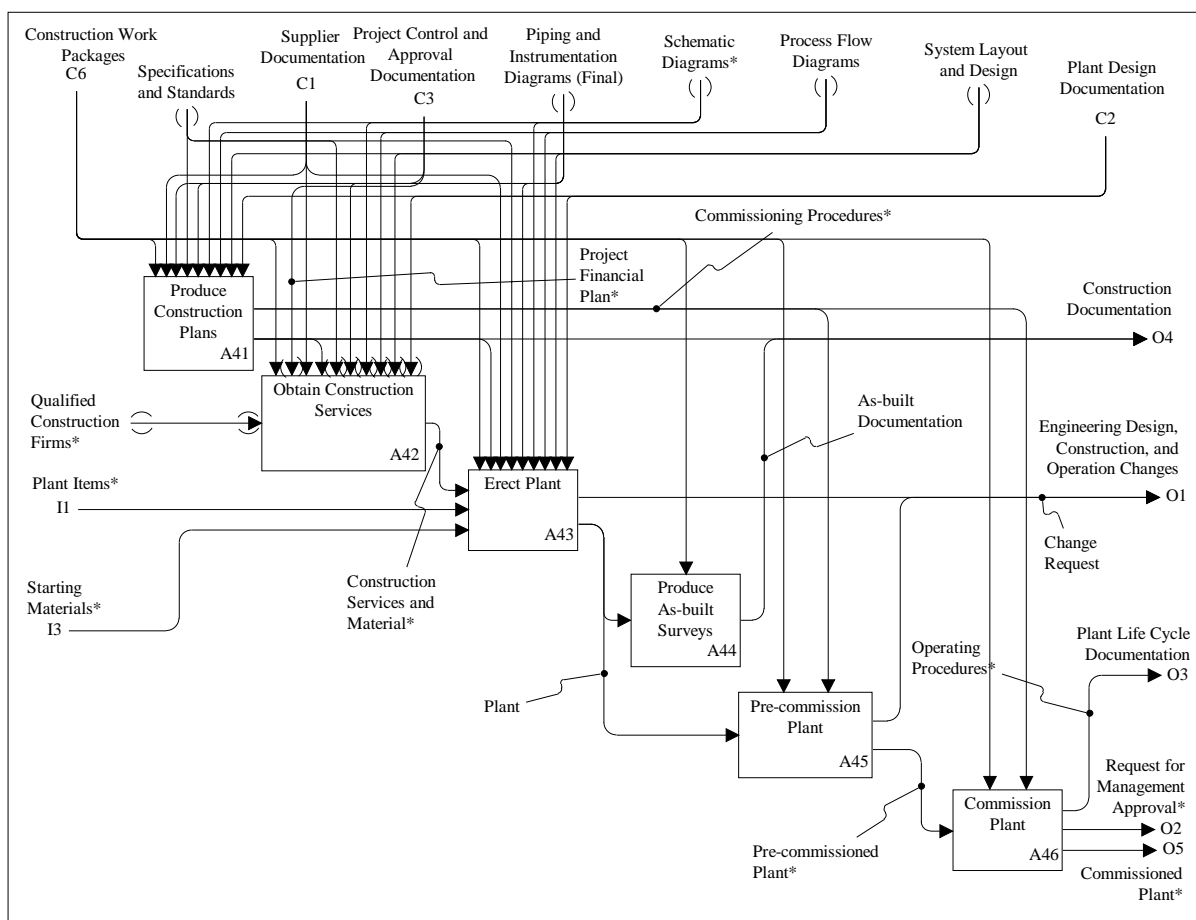


Figure F.14 - A4: Construct and Commission Plant

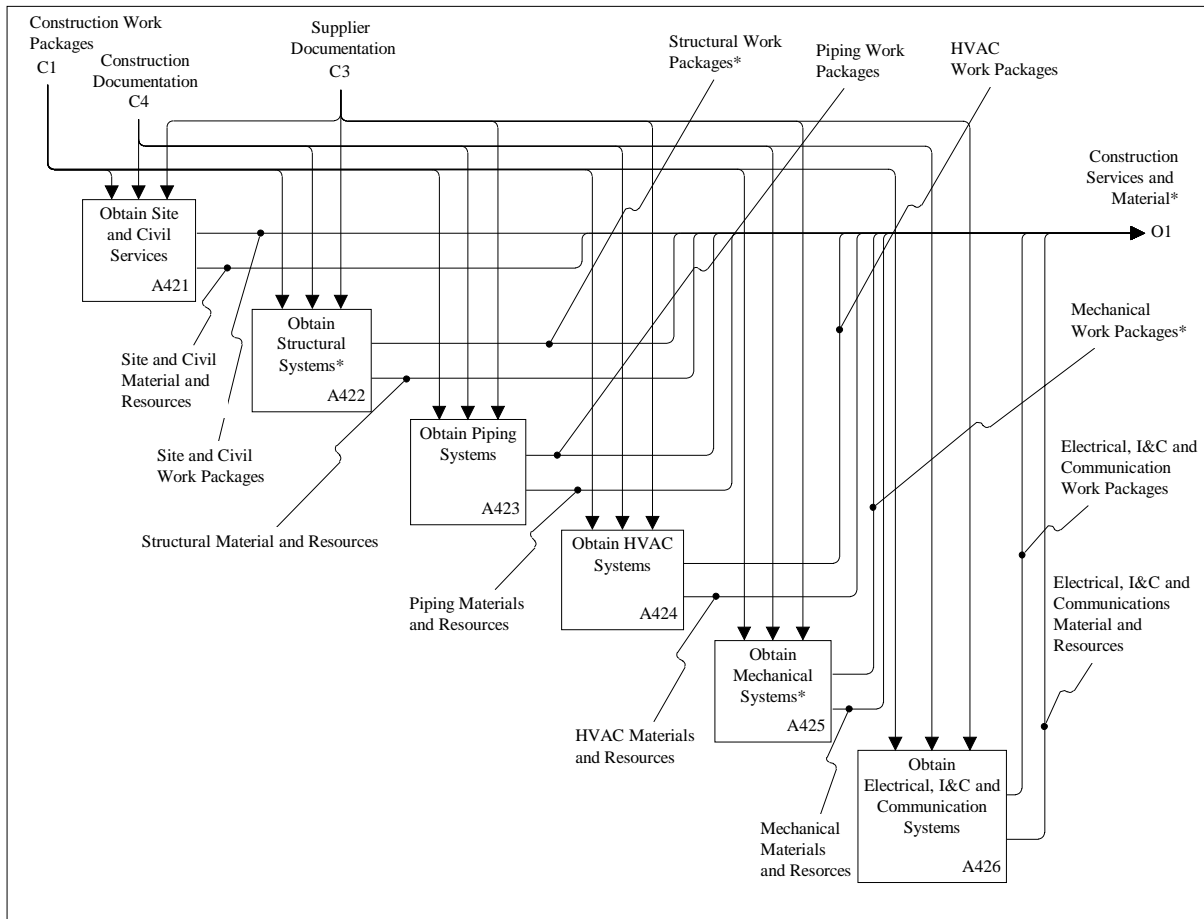


Figure F.15 - A42: Obtain Construction Services

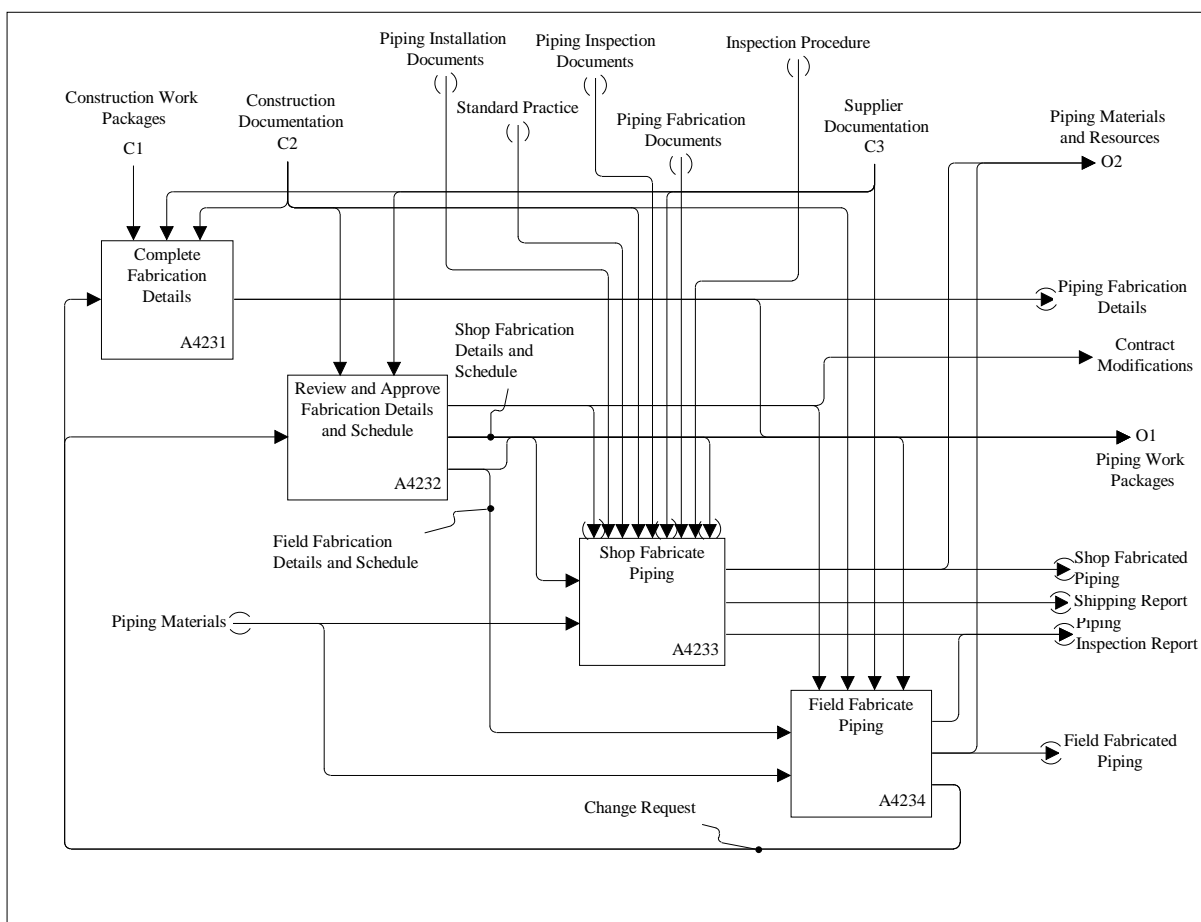


Figure F.16 - A423: Obtain Piping Systems

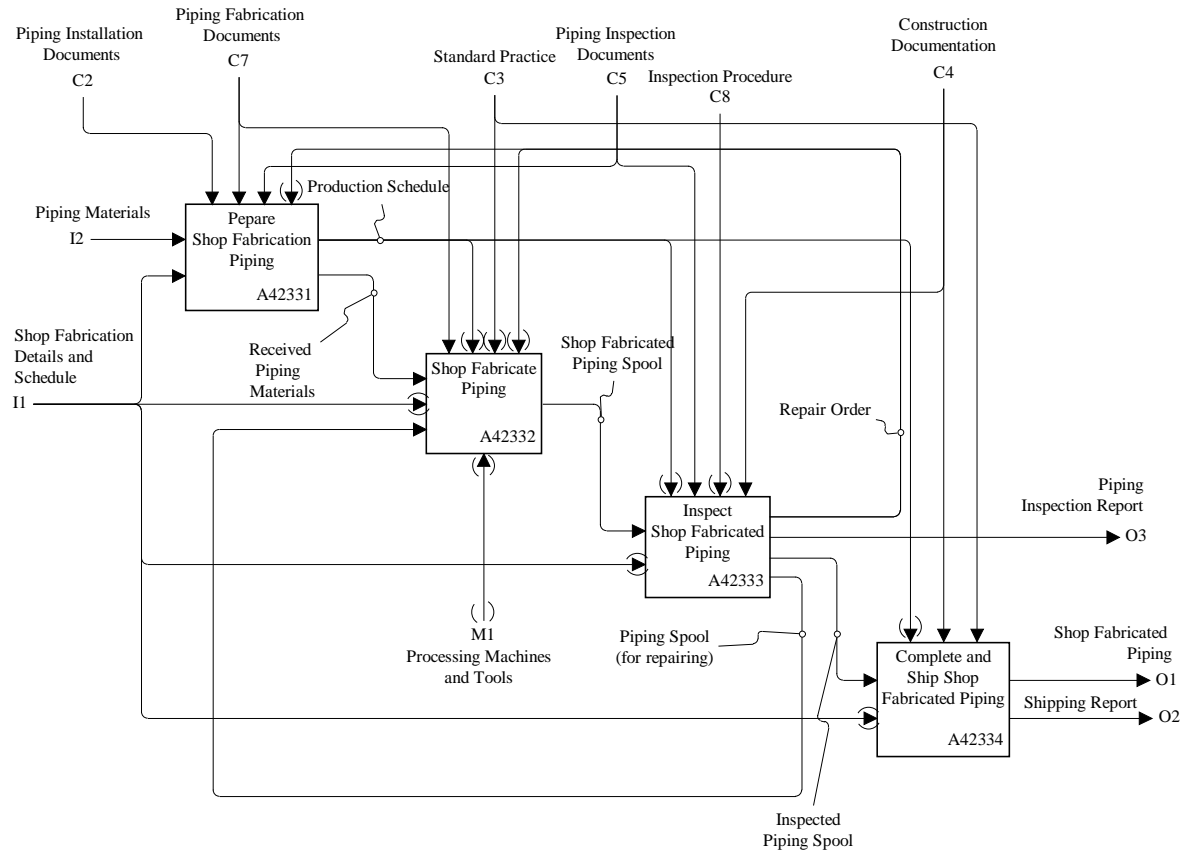


Figure F.17 - A4233: Shop Fabricate Piping

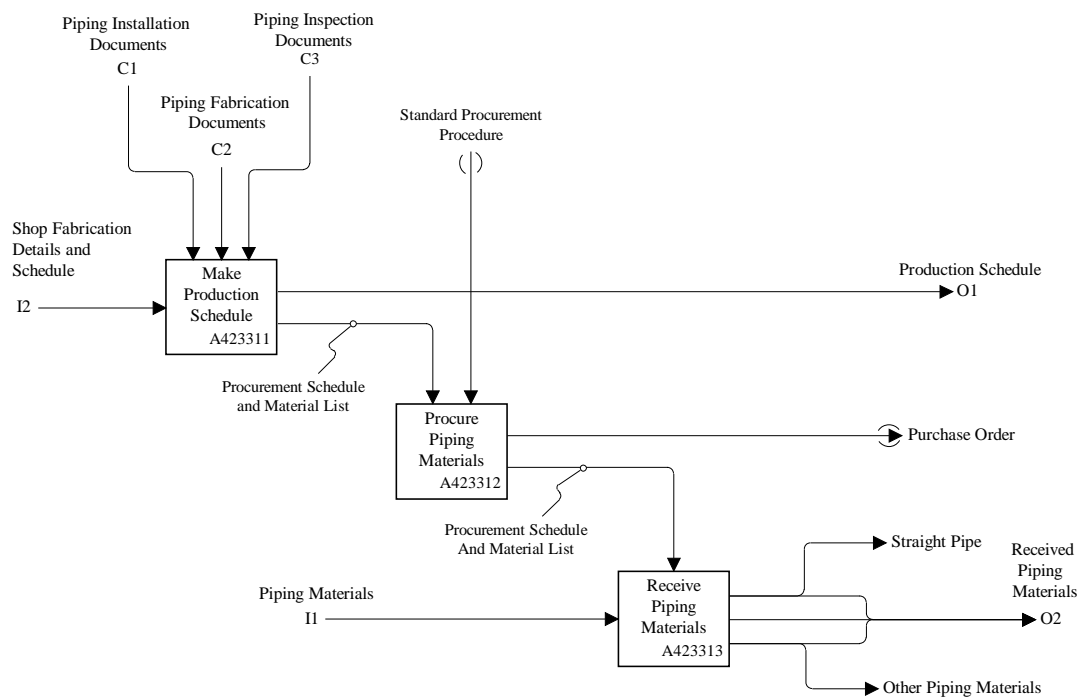


Figure F.18 - A42331: Prepare Shop Fabrication Piping

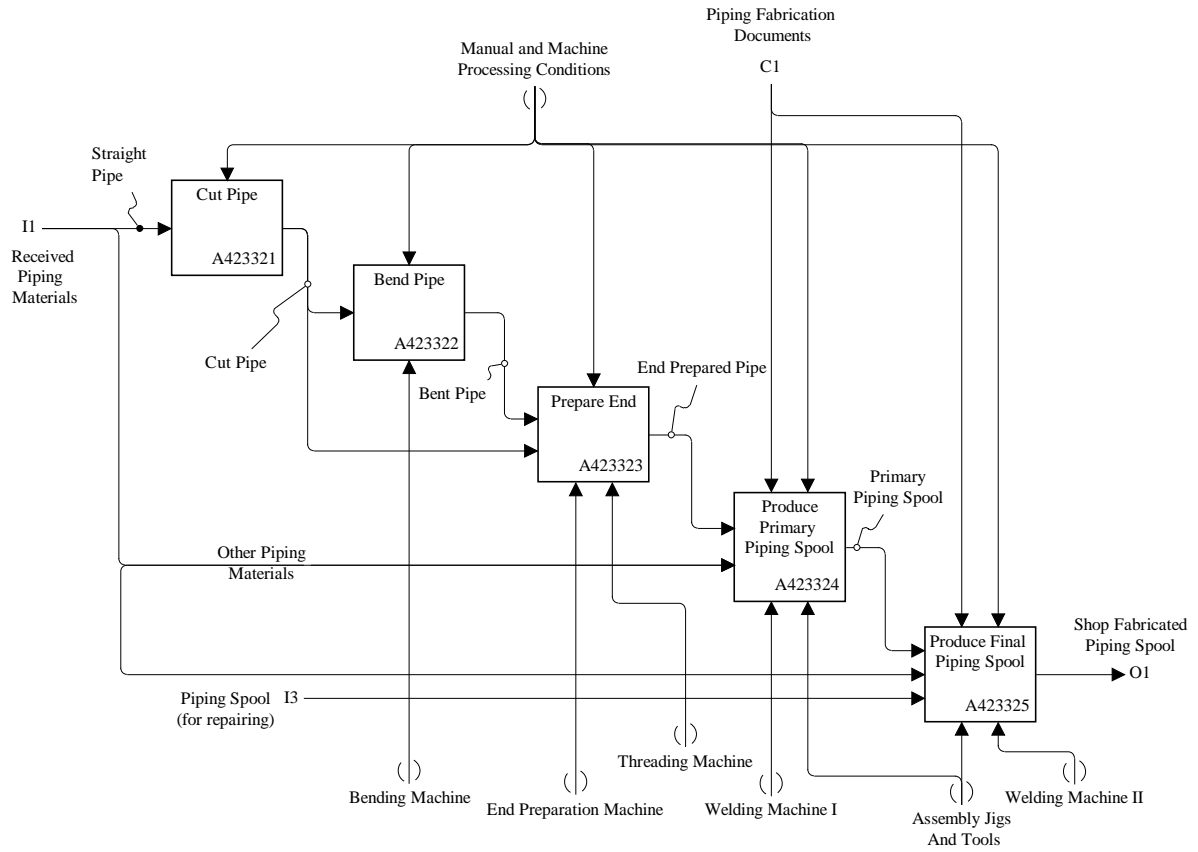


Figure F.19 - A42332: Shop Fabricate Piping

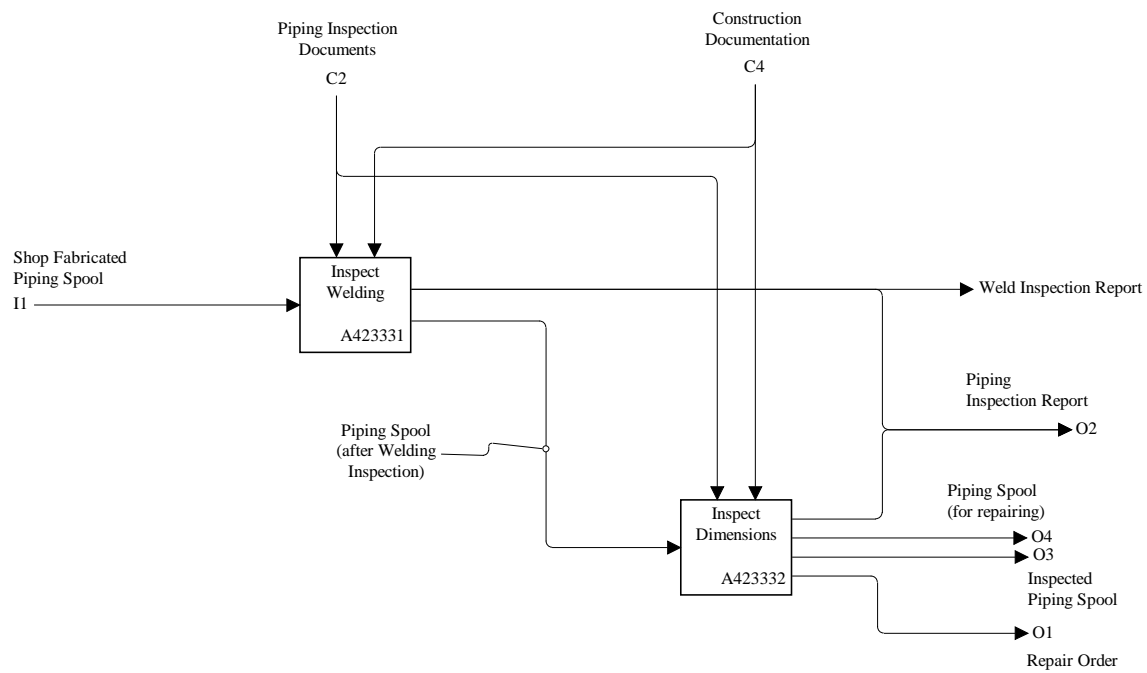


Figure F.20 - A42333: Inspect Shop Fabricated Piping

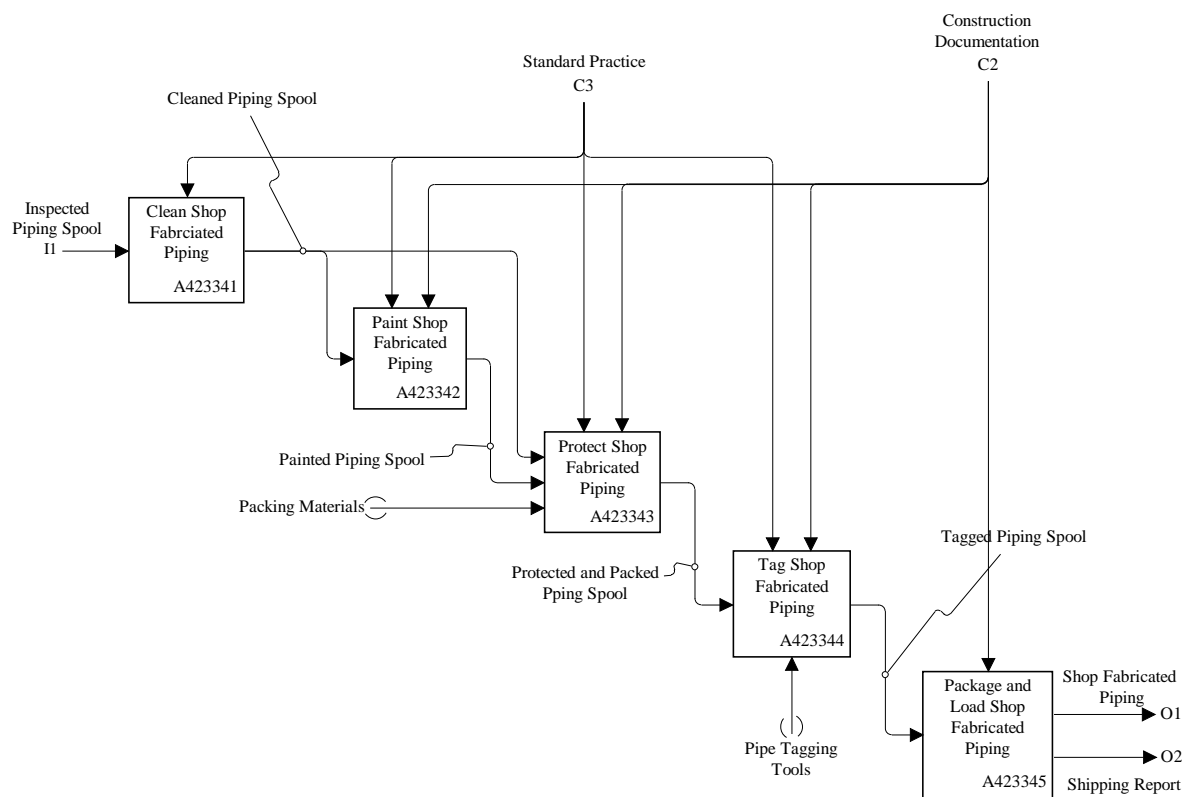


Figure F.21 - A42334: Complete and Ship Shop Fabricated Piping

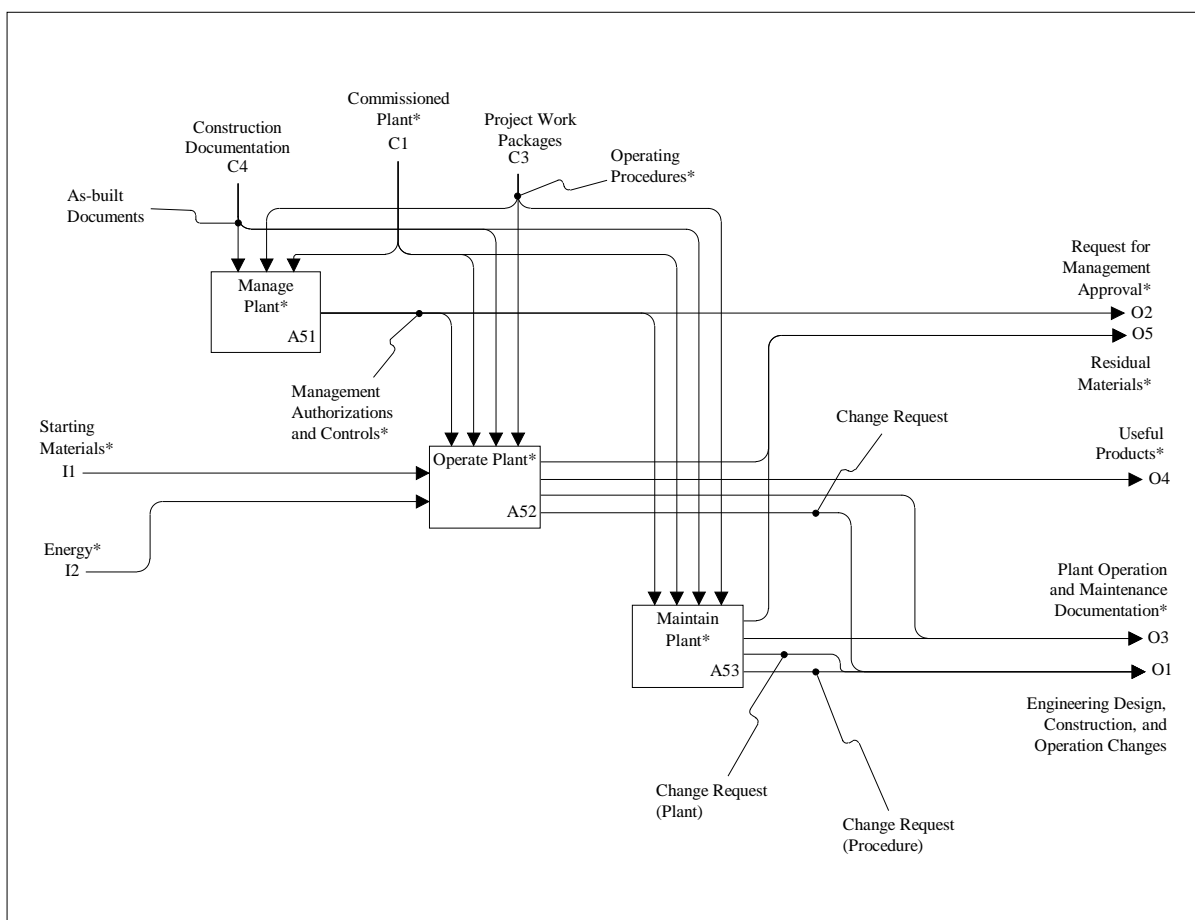


Figure F.22 - A5: Manage, Operate, and Maintain Plant

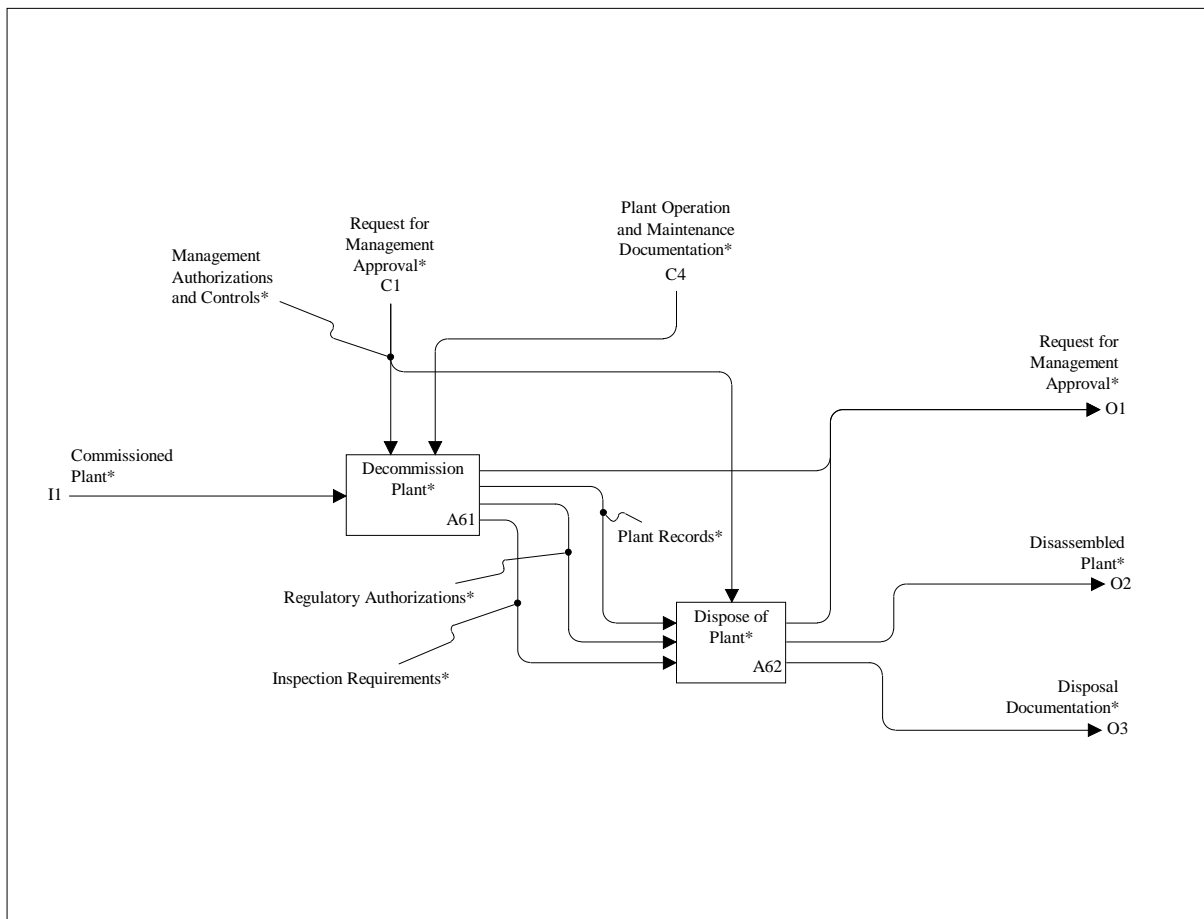


Figure F.23 - A6: Decommission and Dispose of Plant

F.3 AAM/ARM Correspondence

An analysis of the correspondence between the in-scope data flows of the AAM and the ARM has been completed. This analysis mapped the in-scope inputs, controls, outputs, or mechanisms (ICOMs) identified in this annex to the ARM UoFs and entities identified in 4.1 and 4.2, respectively. The AAM ICOMs and their corresponding ARM UoFs and entities are shown in Table F.1. The results of this analysis indicated that all of the in-scope ICOMs were covered by one or more ARM entities.

Table F.1 - AAM ICOM to ARM UoF/entity mapping

AAM ICOM	ARM UoF	ARM Entity
Change Request Change Request (Design) Change Request (Plant) Change Request (Procedure) Change Request (Supplier List)	Change_information	All entities in the UoF
Equipment Characteristics (Functional) Equipment Characteristics (Performance) Equipment Characteristics (Process) Equipment Characteristics (Required) Equipment List Equipment ID	Equipment_characterization	All entities in the UoF
	Piping_component_- characterization	All entities in the UoF
Codes Corporate Standards Design Basis Guidelines and Requirements Owner Requirements Project-specific Documents Regulatory Requirements Safety System Specification Specifications and Standards	Connector	Piping_connector Piping_connector_- service_characteristic
	Equipment_characterization	Equipment
	Piping_component_- characterization	Piping_size_description Pressure_class Schedule
	Piping_system_functional_- characterization	Piping_specification Piping_system Piping_system_line Stream_design_case

Table F.1 - AAM ICOM to ARM UoF/entity mapping - (continued)

AAM ICOM	ARM UoF	ARM Entity
	Plant_characterization	Piping_system
	Plant_item_characterization	Construction_material Design_project Functional_design_view Material_specification_- selection Physical_design_view Piping_system_- component Required_material_- description Specification_item_- family Structural_component
Line Schedule and List	Piping_system_functional_- characterization	Line_piping_system_- component_assignment Piping_system_line
Material Requirements	Plant_item_characterization	Material_specification_- selection Material_specification_- subset_reference
Plant	Plant_characterization	Plant
Plant Items	Plant_item_characterization	Plant_item
Plant Performance Requirements	Plant_characterization	Functional_plant Plant Plant_process_capability
Site Information (Existing)	Site_characterization	Site
Status	Change_information Shape	Change Plant_item_- interference_status
Stream Data	Piping_system_functional_- characterization	Stream_design_case Stream_phase
System Design (Preliminary) System Layout System Layout and Design System Layout and Design (Preliminary)	Piping_system_functional_- characterization	All entities in the UoF
	Plant_characterization	All entities in the UoF
	Plant_item_characterization	All entities in the UoF

Table F.1 - AAM ICOM to ARM UoF/entity mapping - (continued)

AAM ICOM	ARM UoF	ARM Entity
	Site_characterization	All entities in the UoF
Supplier Data	Equipment_characterization Plant_item_characterization	Equipment Catalogue_definition Catalogue_item

The analysis also indicated that the scope of the AP described by the ARM is more refined than that of the AAM in that not all of the entities defined in the ARM map back to an AAM ICOM. A listing of the ARM entities is provided in table 4 of the *Application Protocol 227 Validation Report Version 1.1* [11]. This listing shows whether an ARM entity is related to an AAM ICOM, and if not, what UoF it is part of. The results of this review show that the all the ARM entities that are not mapped from an AAM ICOM are related to connections between items (connection and connector UoFs), item representation (shape_representation and wireframe_geometry UoFs), or item shape (shape UoF).